ANNALS OF SURGERY

VOL. L. OCTOBER, 1909 No. 4

ORIGINAL MEMOIRS.

AN ANALYTICAL AND STATISTICAL REVIEW OF ONE THOUSAND CASES OF HEAD INJURY.

(*Concluded from vol. I, page 541.*)

BY CHARLES PHELPS, M.D.,

OF NEW YORK CITY,

Surgeon to Bellevue and St. Vincent's Hospitals.

V.—PUPILS.—The abnormalities of the pupils are so varied that they are best expressed in tabular form, as they were noted in those fatal cases of the second series in which necropsy was permitted. They are fully representative of the already published cases of the first series (*lib. cit.*).

Both pupils widely dilated	7
One pupil widely dilated	3
Both pupils fully or moderately dilated	22
One pupil fully or moderately dilated	19
Both pupils contracted	11
One pupil contracted	3
Normal	36
	101

A similar analysis of recovering cases in the same series affords, with allowance for their greater number, results not essentially different.

Both pupils widely dilated	7
One pupil widely dilated	2
Both pupils fully or moderately dilated	56
One pupil fully or moderately dilated	38
Both pupils contracted	17
One pupil contracted	7
Normal	147
	274

Percentages:

Normal pupils—Fatal cases..... 35%
Normal pupils—Recoveries 53%

It is probable that the percentage of normal pupils in recovering cases would be somewhat increased if the record had been complete; since in so large a number in which the pupils are unmentioned there is internal evidence that the normal condition was intended to be assumed.

While the percentage of normal pupils is thus much greater in recovering than in fatal cases, the difference is still insufficient in itself to be of value in prognosis. It may be said also in very general terms that the abnormal pupillary conditions in individual cases are of no material assistance in forecasting the result. Death and recovery ensue with both dilated and contracted pupils and whether reaction be lost, impaired, or unaffected. Recovery may follow even when dilatation is extreme and reaction entirely wanting, or death when both conditions are normal. It was thought by Mills [18] that "the more insensitive, dilated and immovable the pupils, the less favorable the prognosis." The analysis of these cases sustains this opinion in one particular. In the few cases in which dilatation was noted as extreme ten were fatal and nine recovered. The pupils were immovable in all the fatal cases, and with exceptions, were either normal or sluggish in reaction in those which recovered. The extremity of dilatation with complete fixation therefore may be considered of fatal import, though in one case of recovery, which is apparently exceptional, dilatation was extreme and reaction was entirely wanting as it was in several others in which dilatation was less complete. The danger, however, does not increase progressively with the extent of dilatation or of immobility. Death equally occurs with slight dilatation or none at all, or with contraction, and in either case with normal or but slightly impaired mobility; recovery occurs under the same conditions; and neither death nor recovery can be anticipated from the extent of dilatation or degree of fixation, except as stated when both together are

[18] Trans. Congress Am. Phys. and Surg., 1889, vol. i.

removed to the farthest possible distance from the normal state.

The phenomena of pupillary disturbance are many and varied. Their size may be symmetrically or unsymmetrically increased or diminished, and with an alteration in size either one or both may or may not be wholly, or in some lesser degree, without reaction to light or to accommodation or to both; or it may occasionally happen that with no alteration in size reaction may be wanting. The pupillary symptom, though usually primary may be secondary; or again it may change from time to time in the progress of the case; but whatever its nature or period of observance it has no characteristic relation to other symptoms with which it may be associated.

The abnormal pupil is indicative of intracranial lesion, though not necessarily of traumatism, and is so far diagnostic. It has been held in times past that all intracranial injuries were divisible into concussions and compressions; and lesions were ignored, except as to a recognition of bone, blood and pus as compressing agents; if it was concussion the pupils were contracted; if compression, they were dilated. If traumatisms are to be classified in accordance with pathogenic lesions, as better knowledge of their nature and greater accuracy of nomenclature now demands, it will be evident from the post-mortem examination of cases which have been cited that no pupillary condition is representative of any particular form of injury. Such an examination can lead to no conclusion except that any pupillary derangement, or none at all, may be associated with every form of intracranial injury, limited or diffuse, single or multiple, or implicating any cerebral area.

It was believed by Mr. Hutchinson that dilatation and fixation of a single pupil denotes a compression of the motor oculi communis nerve by a hemorrhage into the middle basal fossa of the same side. This explanation though perhaps true of a limited number of cases fails to be substantiated in the much larger number.

In 15 cases of the present series a single pupil was fully or moderately dilated and without reaction; and of these 4

were found to conform to Mr. Hutchinson's formula. The pupil was widely dilated in but 1 of the 4; in this an epidural clot covered the whole hemisphere and extended into the middle and posterior fossæ. In 3 cases in which dilatation was but moderate, hemorrhage in one filled the whole cranial cavity, in another occupied both middle fossæ, and in the third extended only beneath the frontal lobes. The remaining cases afforded no support to the Hutchinsonian contention. Two in which the pupil was widely dilated were cases of laceration; 5 with moderate unilateral dilatation disclosed extensive lesions, all of which were on the opposite side; and in the final 4 there was no basal hemorrhage.

Several other cases in which dilatation was slight may be neglected. The concomitant lesions were varied, but in no case included hemorrhage into the corresponding middle fossa.

There is an anatomical reason for admitting a direct relation to exist between the dilated pupil and the hemorrhage into the corresponding middle fossa; but there are also clinical reasons which compel the recognition of an equally positive, if less direct and obvious, relation between this pupillary change and every other form and site of intracranial lesion. The conclusion of Mr. Hutchinson would seem to have been another instance of too wide a generalization from too narrow a basis of observation.

Both pupils were widely dilated in 7 cases, and were irresponsive in all but one, and in this the reaction was limited to accommodation. In each a hemorrhage, epidural, pial, or cortical, was notable though in each with a single exception there was also laceration of importance. In 22 cases of less extreme dilatation the lesions were more varied. There was in 50 per cent. of these no hemorrhage at all, or none of importance, but a general contusion, pial or cerebral or both, with or without laceration or subarachnoid serous effusion. In several of the others in which hemorrhage was the most prominent lesion laceration was also a well marked feature. It follows that as hemorrhage was the most noteworthy lesion when dilatation was extreme, it was a general contusion when dilatation was of lesser extent.

There was contraction of a single pupil in only 3 cases, and in each the pupil was immovable. Large hemorrhages and a general contusion, which in one instance involved an extensive subcortical laceration, existed in all of them. In the 3 cases considered together all the basic fossæ, and the whole laterosuperior aspect of one hemisphere, were included in the hemorrhages.

In 11 cases, in which both pupils were contracted, hemorrhage was the prominent lesion in 3, general contusion in 6, and a co-existent hemorrhage and contusion in 2. As in unilateral contraction, there was no region of base or vertex which escaped some form of lesion.

The pupils were normal in size and reaction in a large percentage of all the cases examined. The lesions in these cases defy inductive analysis. They comprise all varieties of intracranial hemorrhage and involve every part of base and vertex; they include extreme contusions of both brain and meninges, and lacerations of all the cerebral ganglia except the respiratory and the cerebellum.

ILLUSTRATIVE CASES.

The only example in this series of a wide dilatation and fixation of a single pupil with hemorrhage into the corresponding middle fossa, as shown by necropsy, has been already quoted in illustration of asymmetrical radial pulsations. (Case XLIII—Pulse.)

CASE LV.—*Wide Dilatation of a Single Pupil, with Recovery.*—A man was found at the foot of a stairway in a condition of stupor with widely dilated and irresponsive right pupil, profuse hemorrhage from the right ear, and frequent pulse and respiration. On admission to the hospital he was in shock, restless, and not wholly conscious; his right pupil was still dilated and irresponsive; and he had hæmatemesis, headache, and a lacerated wound in the left parietal region. He had no symptoms except headache after the day of admission.

CASE LVI.—*Dilatation and Fixation of Right Pupil with Lesions Confined to Opposite Side. Necropsy.*—A man fell down stairs, a distance of fifteen feet, and was primarily unconscious. On admission to the hospital he was still unconscious with tem-

perature 99°, pulse 90, and respiration 24. A wound in the right occipital region, was the only evident external injury. The right pupil was dilated and without reaction; the left radial pulse was fuller and more forcible than the right; vesical control was lost; and there was complete paralysis and anæsthesia of the right side. On the second day the movements of the leg were temporarily restored, both pupils became contracted and sensitive to light, temperature increased, and he became restless with some indications of consciousness, but not of intelligence. On the third day the mental condition was unchanged; loss of rectal and vesical control and asymmetry of the radial pulsations was continued, and right hemiplegia was again complete. Subconjunctival hemorrhage appeared in the left eye, and there were moist bronchial râles. He died on the fourth day, pulmonary œdema having increased, paralysis having become complete and unconsciousness more profound, and temperature having progressively risen to 107.6°.

Lesions.—Skull of great thickness and density; separation of left occipitoparietal and occipitotemporal sutures; fracture through left posterior basal fossa into foramen magnum; slight epidural hemorrhage on left side of internal occipital tuberosity; slight pial hemorrhage over left temporal lobe; thick cortical hemorrhage covering anterior border and base of left frontal lobe and first and second left temporal convolutions; subcortical laceration and excavation of whole left frontal, and anterior two-thirds of left temporal lobe; subcortical disintegration of left optic thalamus; small hemorrhage into left corpus striatum; and deep laceration across posterior border of left occipital lobe. Brain moderately hyperæmic.

Case LVII.—*Wide Dilatation and Fixation of Both Pupils. Recovery.*—A man was struck on the head by a tack[1] block which had fallen about thirty feet. He was found by the ambulance surgeon unconscious, and with both pupils widely dilated and irresponsive to light or accommodation. On admission to the hospital his mental and pupillary conditions were unchanged; temperature 97.4°; pulse 92; respiration 26. He had an extensive and greatly comminuted fracture of the left parietal bone. The membranes were so lacerated that they were indistinguishable; much brain matter was lost; and portions of scalp, fragments of bone, hair and dirt were driven into the cerebral substance. The

wound was cleansed and dressed, and in about one hour consciousness was restored. The pupils were still widely dilated and irresponsive. He vomited, and the bowels were moved by enema. Rectal and vesical control was subsequently lost and not regained for several days. The pupils did not begin to contract or to react till in the second month.

The history of this case is mainly one of mental decadence from left frontal lesion and has been described at length in a monograph published in the *American Journal of Medical Sciences,* May and June, 1902, Case IX,—and is again reproduced later in the consideration of left frontal lesions (Case LXXXIII) and of pupillary derangements (Case LVII).

VI.—The Loss of Rectal and Vesical Control.—The term loss of control is used here comprehensively to indicate that disorder of the rectal and vesical sphincters which is manifest in ways generally known as incontinence of urine and fæces, and urinary retention. Fecal retention from atony of the rectum, due to local causes, is so common in all conditions of health and disease and so impossible to distinguish from a special form if such exist, corresponding to urinary retention that it must necessarily be ignored. Incontinence has been so often held to denote a relaxation of the sphincters which permits dribbling of urine or a continuous escape of fæces, that misapprehension might ensue if the same word were used to designate the very different condition which obtains in cases of intracranial injury. In default of a single word by which this condition may be expressed with exactitude the phrase loss of control has been substituted. As a matter of further convenience by a rhetorical license, it has been limited to the large majority of cases in which abnormal retention is not a feature; the latter to be considered later as a subdivision of the general subject.

In those cases of intracranial injury in which the rectal and vesical sphincters are involved there is in general neither muscular atony, paralysis, or spasm; but simply an automatic reflex action by which the urine or fecal matter is avoided independently of volition, either with or without the conscious-

ness of the patient. The passage of urine differs from normal micturition in only one necessary particular, the absence of volition. It is usually discharged in practically normal quantity at practically normal intervals, whatever may be the nature of the intracranial lesion. Paralytic incontinence is usually the result of a neglect to relieve active retention, and as such has no claim to recognition as a symptom of injury. A relaxation of the sphincters may occasionally occur when unconsciousness is profound, but it is exceptional, and in nowise characteristic.

In a study of abnormal rectal and vesical conditions they were found to have been specifically noted in more than 350 cases. These cases, whether fatal or ending in recovery, comprised: those in which rectal and vesical control was lacking primarily or secondarily, separately or together; those in which urine was abnormally retained; and finally, those in which rectal and vesical functions were normally performed.

The statistical results of this examination of cases in which rectal or vesical control was lacking were as follows:

Recoveries	73
Deaths	154
	227
Necropsies	144
Primary Loss	123
Secondary Loss	104
	227
Loss of both Rectal and Vesical Control	111
Loss of Vesical Control Alone	102
Loss of Rectal Control Alone	14
	227

If to these cases there is added those of urinary retention, those in which death occurred too soon for urinary or fecal discharges to take place, and those in which it is specifically stated that these functions were normal, it will make the aggregate of 350 or more cases.

The large remainder of cases, somewhat less than 650, comprise those in which these functions failed of mention, either from neglect or because in the absence of mention their normal condition was intended to be assumed. It is probable that with a proper allowance for these cases the percentage of recoveries would be largely increased.

A recital in detail of the results of observation in the whole number of cases would be unnecessarily fatiguing, but the significance of such rectal and vesical disorders is sufficiently obscure and heretofore unconsidered to warrant some detail in analysis of at least those of the later cases in which symptoms could be confronted with lesions.

In 90 cases of the second series, in which necropsy was made, these rectal and vesical conditions had been noted:

Loss of both Rectal and Vesical Control	37
Loss of Vesical Control Alone	23
Loss of Rectal Control Alone	4
Abnormal Retention of Urine	11
No Fecal or Urinary Discharge	12
Normal Control retained till Death	3
	90

Primary control of both functions was retained in 16 cases, and in each the patient was conscious, and in 6 was without mental impairment. Twelve of these lost rectal or vesical control, or both, in from two to eleven days; and when the loss occurred on the second day it was always attended by stupor, unconsciousness, or delirium.

Primary loss of control was noted in 30 cases under varied mental conditions: Consciousness with normal mental state obtained in 2; stupor or delirium in 6; and unconsciousness in 22. Control was not regained in either of those primarily conscious, whether the mental state was normal or abnormal, and in only three of those primarily unconscious.

A loss of rectal or vesical control was as often secondary as primary, *i.e.*, was first noted at some time subsequent to the day on which the injury was received. In a certain number of these cases primary control is definitely stated in

their history. In the larger number no mention is made of its presence or absence. In 50 per cent. of those in which such mention is neglected the patient was conscious; in 25 per cent. he was unconscious; and in 25 per cent. he was in stupor or delirium. The fact that in a large proportion of those cases in which this point in history failed of record on the first, it was noted on the second day would seem to suggest that there was neglect in noting the earlier condition. It may also be true that in the absence of note to the contrary its presence was meant to be inferred.

On the day when secondary loss of control was first noted the patient was usually unconscious, delirious or in some degree mentally incompetent. In 3 cases only was control regained; 2 of these were delirious primarily as well as when control was lost, when it was regained and when lost again, the third, in which rectal control alone was lost and at variable intervals, suffered progressive mental decadence. The lesions were respectively: moderate epidural and extensive pial hemorrhage, marked cerebral œdema, severe pial contusion with subarachnoid serous effusion; cortical hemorrhage from frontal lacerations; and great cerebral hyperæmia and œdema; and in the case last mentioned cerebral sclerosis and marked left frontal atrophy.

In more than 50 per cent. of the cases involved rectal and vesical control were lost together, and in all those remaining, save four, it was the bladder which was alone at fault; and when the bladder and rectum were successively, and not simultaneously affected, it was the bladder control which was usually lost primarily.

In 1 of the 4 exceptional cases, in which rectal control alone was lost, the patient was conscious until his death twelve hours after admission to the hospital; in another he was slightly delirious, and control was lost on the second day, death occurring on the third; in a third case, the patient who was then delirious required catheterization on the second day, voided urine naturally on the third, lost vesical control on the fourth, lost both rectal and vesical control on the fifth, regained both

on the eighteenth, and again lost both on the twentieth day. The lesions disclosed did not account for these anomalous conditions. The first mentioned of these cases was that of a gunshot laceration of both cerebellar lobes with cortical hemorrhage at the vertex and in both posterior basal fossæ; the notes of necropsy of the second were confined to fracture; the temperatures, however, had indicated a general cerebral contusion; the third case showed marked cerebral hyperæmia and œdema with lacerations of the right frontal and temporal lobes, and a considerable cloudy subarachnoid serous effusion, and no hemorrhages. In the fourth and last exceptional case, which was of long duration, vesical control was maintained throughout. Rectal control was occasionally lost in the early part of the second month, but toward its end was again perfect. At the end of a year it was habitually lost for about three, and in the fifteenth month for about two days out of seven. The patient died soon afterward. His mind until near the close of the year was active; he was coherent, capable of initiative, and suffered only from delusions which for a long time were confined to locality,—later, mental decadence was general and progressive. He was found at necropsy to have suffered general cerebral sclerosis and marked left frontal atrophy as has been noted in another connection.

The loss of rectal control alone with later necropsy occurred in the first as it did in the second series of cases in three instances only, but in one of them not till final unconsciousness on the seventeenth, and last day of life. In one of the two remaining cases it was confined to a period of primary unconsciousness, and in the other it was secondary, and the mental condition was one of stupor; in both there was found a temporal laceration and extensive cortical hemorrhage.

In each series there was a very limited number of cases in which primary rectal was followed by considerably later vesical loss; and a further limited number of cases in which with primary vesical a later rectal loss followed before both occurred together. A case from the second series will be cited later as illustrative of the conditions last mentioned.

The number of fatal cases without necropsy, as well as of those which recovered, in which loss of rectal control occurred independently of vesical loss, was as limited as that of those with vesical loss already considered. The whole number in all cases of both series (1000 cases), in which with rectal loss vesical control was at the same time primarily and permanently retained was but fourteen, and the number in which independent rectal loss followed primary vesical loss, or alternated with it, was still less. The attendant conditions as regarded states of consciousness and mental competency were the same in both fatal and recovering cases. The paralysis and diminished reflexes observed in one instance cited were not noted in either of the others examined. Coincident retention of urine with necessary catheterization occurred in a noteworthy proportion of cases.

In fatal cases in which both vesical and rectal, or vesical control alone, was lost and in which post-mortem examination was not practicable, attendant conditions were naturally similar to those already noted where such opportunity was afforded. In 50 per cent. of these, primary control was retained with more or less complete unconsciousness, delirium, or rational intelligence. Cases of rectal or vesical default, occurred from the second to the forty-second day. When control was long maintained the patient was in some instances in stupor but fully conscious and intelligent at time of final loss.

In recovering cases these losses were in much smaller proportion. The loss when it occurred was much oftener primary than secondary, without regard to mental condition, and as in the fatal cases was usually vesical when only a single function was involved. The loss if secondary usually occurred on the second or third day. In one instance, however, control was retained till the thirteenth day, when vesical control was lost. The patient, previously delirious, was then rational though apathetic.

Loss of control as it has been considered has referred exclusively to unconscious or involuntary discharges from the

bladder or rectum. In a very much smaller number of cases there was an abnormal retention of urine which required catheterization. The whole number of cases in both series was 53, scarcely more than 5 per cent. of the total of 1000. Twenty-eight were fatal and in 17 of these the use of the catheter was required on the first day as it was in 16 of the 25 recoveries. In the others retention occurred from the second to the eleventh day. The pupils were in most instances abnormal, and much oftener dilated than contracted. Coincident fecal discharges, with or without control, occurred in a number of instances, and when life continued for some length of time, especially if the ending were fatal, rectal or vesical discharges occurred secondarily without volition. The mental states, and the lesions when disclosed, were as varied, as were those in cases previously examined in which discharges were without normal restraint.

It appears from this review of both fatal and recovering cases that rectal and vesical control is lost or retained under all mental conditions and following all recognizable forms of cerebral injury. The same patient may lose and regain, or retain and subsequently lose control during a continuance of the same mental state. It is equally independent of muscular power or of general reflex conditions.

As in many cases the patient is unconscious, or actively delirious, the loss of control might be supposed to depend in them upon deficient perception or deficient will power, as it may do under the same conditions in cases apart from intracranial traumatism. This explanation, however, does not serve to account for the default in the large number of cases of mild delirium, delusional mental disorder or moderate degrees of stupor; and still less for the considerable number of others in which entire consciousness and rational intelligence are maintained.

It is impossible to find an explanation for the rectal or vesical defect in the character or site of intracranial lesions. They have been found to be both limited and diffuse, nearly always multiple, and to affect all cerebral and meningeal

regions. In a study of the first series of cases it was ascribed to cerebral laceration; and a consideration of those cases probably seemed to justify a conclusion. The post-mortem findings in the present larger number of cases fail to confirm its correctness. Laceration, in fact, existed in somewhat less than half of the number comprised in the combined series, and in many was complicated by hemorrhage, and in all by some farther manifestation of a wider cerebral injury. In a large percentage of cases it involved the left frontal lobe, but not sufficiently often to warrant an association of the rectal or vesical default with the usual mental defects dependent upon lesion of that region. In view of the universality of the general lesion, and in the absence of a constant or even characteristic limited brain injury, it is evident that the sphincters have no special centres of even contributive control corresponding to those which have been demonstrated for other muscles.

In a "Contribution to the Pathology of the Sphincters" (ANNALS OF SURGERY, 1901, vol. xxiv, Corner), the writer after observing 100 cases of head injuries, and remarking that figures are valueless concludes that "the figures themselves show that the main cause (of affection of the sphincters) is the amount of violence; as in concussion of the brain the affection of the sphincters is infrequent, whilst in fractures of the skull, etc., they become more frequently affected." To this statement it may be excepted: first, that the amount of violence inflicted upon the cranial contents is not to be measured by the occurrence of fracture, or its absence; and second, that the dependence of affections of the sphincter upon the amount of violence inflicted can only be determined by the figures which he contemns. As a matter of fact intracranial injuries are no less severe when the cranium is intact; and a reference to the records of the cases cited in this paper shows that in them in proportion to their number affections of the sphincter are no more frequent with fracture than without. It has been further shown that in the 1000 cases 217, or nearly one-fourth, were without fracture, while loss of control in them occurred in a ratio of one to three as compared with

those in which fracture was an incident. If it be true that affections of the sphincters are frequent in proportion to the amount of violence inflicted, *ceteris paribus,* it is no less true of other symptoms of importance.

The same author arrives at certain other conclusions which are equally at variance with those deducible from observations made in the present series of cases. His classification is simple and seemingly independent of pathology. "Concussion is a condition in which the symptoms are most severe at the time of the receipt of the injury, and then progress favorably;" while in compression "they get progressively more severe if allowed to take their course"; and "fractures of the skull present in their general symptoms the signs of concussion, compression being excluded, and the diagnosis of contusion or laceration of the brain uncertain." It is of course impossible to follow his study of disordered action of the sphincters with such a classification of cases if we accept a present pathology in which concussion disappears, compression apart from contusions becomes most infrequent, and cranial fracture has few general symptoms of importance, except through its complications which are identical with those conditions which equally occur in its absence. His first subdivision would include all cases of recovery, urinary retention occurring in nearly 23 per cent. as against less than 5 per cent. in all classes of recovering cases in the present series. His cases of compression would probably be identical with those in which are found the lesions of contusion; in these he states, "active retention will rather probably have occurred during preliminary concussion which passes on to the passive retention of paralysis, and when the symptoms of compression are marked paralytic overflow takes place."

This has not been the history of the cases upon which the present paper has been based.

Finally: 8 out of his 13 cases of cranial fracture, nearly two-thirds of their number, "showed affection of the sphincters, all of which were active retentions, 4 being allowed to proceed to incontinence."

This percentage differs widely from that noted in the

cases which have been cited here. Urinary retention occurred in only 39 out of 783 cases, none of which were permitted " to pass on to the passive retention of paralysis."

Normal urination is an automatic reflex action wholly dependent upon the sympathetic system. The habitual intervention of consciousness and volition is not essential to the proper performance of the function. The expulsive force of the detrusor muscle is excited exclusively through the ganglia of that system, and the restraining power of the vesical sphincter is so far controlled by them that even in health the influence of the cerebral centres may be suspended when excitation has reached a certain degree of intensity. The interposition of consciousness and volition while not essential to the voidance of urine is nevertheless requisite to the well-being of the individual, and when prevented is indicative of functional or structural disease. The cases of intracranial traumatism which have been cited show not only that the methodical expulsion of the rectal or vesical contents may continue for a length of time when both consciousness and volition are wanting, but that with full consciousness and with volition otherwise unimpaired these discharges may be involuntary.

It is evident from this view of the facts connected with uncontrolled action of the sphincters in cases of intracranial injuries:—

That it is a true symptom and not a mere accident of suspended consciousness or mental impairment.

That while of no service in prognosis, or as an indication for treatment, it has much diagnostic importance.

That it is characteristic of intracranial injury, and at the same time independent of the nature or site of lesion.

That it must therefore be an indirect rather than a direct symptom.

That its origin is to be found in some interruption of a harmony of function between the cerebral and sympathetic nervous systems which is a result of direct injury of any part of the brain or its membranes.

That it is thus etiologically allied to asymmetrical arterial pulsations and to pupillary disturbances.

The dependence of abnormal circulatory and pupillary conditions upon a secondary implication of the sympathetic system is even more directly obvious than is that of the uncontrolled action of the sphincters. The exclusive control of the vascular system by the sympathetic must necessarily involve its immediate responsibility for abnormal no less than for normal conditions. The channels through which the influence of the intracranial lesion is exerted is less certain, but it seems probable that it is through the sympathetic filaments which are everywhere distributed upon the cerebral vessels.

The direct connection between the intracranial injury and the abnormal condition of the pupil is more nearly demonstrable. As was long since determined the reflex movements of the iris, though made through the medium of the ophthalmic ganglion, derive their original stimulus through the motor oculi communis nerve. Hutchinson observed the dilatation of the corresponding pupil from direct intracranial pressure of extravasated blood upon that nerve in its passage through the middle fossa. It is conceivable that any other intracranial lesion may more indirectly reach the ophthalmic ganglion through the same channel and produce the same pupillary effect.

It will be unnecessary to cite many cases to illustrate the lack of rectal vesical control when no longer subjected to the will. Case XL (see Temperature) is further illustrative of the purely automatic character of the reflex action of the vesical sphincter in cases of intracranial injury; and in this connection three cases may be quoted in which the distinctly automatic action of the rectal and vesical sphincters is clearly demonstrable.

CASE LVIII.—*Automatic Action of Both Rectal and Vesical Sphincters. Recovery.*—The patient was admitted to another hospital in an unconscious condition following a suicidal pistol-shot wound in the right temporal region. The positive symptoms

were: drowsiness; stupidity and slowness of speech; lack of vesical and later of rectal control; ptosis; and slight dilatation of the left pupil. Temperature rose to 101°. One week later an epidural clot about the size of an English walnut was removed from the left posterior frontal region. Temperature became normal and there was gradual mental improvement. Rectal and vesical control remained in default.

He was admitted to Bellevue Hospital on the thirty-fifth day. His symptoms then were: slight headache; a nervous and restless manner, with at intervals a vacant look; exaggerated reflexes; a distinct ankle clonus; and a lack of rectal and vesical control with full consciousness of natural desire. Ten days later control of both functions was regained.

In a similar case with recovery, after the disappearance of all other symptoms, rectal and vesical discharges were still involuntary although the patient in each instance was conscious of the impending event.

Case LIX.—*Loss of Both Rectal and Vesical Control. Recovery.*—Patient unconscious and vesical control lost on admission to the hospital. On the third day his mental condition was practically normal and vesical control was regained; on the fourth day he was delirious; and on the fifth day had delusions; on both days vesical control was again lacking; on the seventh day he was rational and intelligent but still without vesical control, and with rectal control variably lost or retained; on the ninth day he was mildly delirious and both rectal and vesical control was lacking; and on the tenth and eleventh days though his mental condition was entirely normal, both rectal and vesical control was still lost.

Case LX.—*Primary Vesical, and Secondary Rectal, Loss of Control, with Still Later Loss of Both Together. Necropsy.*—Patient unconscious when admitted to the hospital and vesical control lost.

Second day: patient conscious and rational; incomplete left hemiplegia; continued loss of vesical control.

Third day: vesical control regained; no other change.

Fourth day: patient delirious; muscular power on left side regained; general convulsions; vesical control again lost.

Fifth and sixth days: mental condition normal except for occasional delusions; vesical control regained; rectal control lost.

Seventh and eighth days: mental condition normal; vesical control lacking; rectal control variable.

Ninth day: mild delusions; left arm rigid; deep reflexes diminished; rectal and vesical control both lacking.

Eleventh day: patient rational; patellar reflexes present; no rectal or vesical control; and neither subsequently regained.

Necropsy.—Excessive general meningeal hyperæmia; limited areas of meningeal contusion with corresponding serous and hemorrhagic effusions; subcortical excavation of both frontal lobes.

VII.—Minor Symptoms.—There are certain other general symptoms of minor importance and not peculiar to head injuries. Two of these only are of frequent occurrence.

Vomiting is perhaps the most frequent, and has certainly been accorded the most consideration. Hæmatemesis, the ejection from the stomach of blood swallowed in succession to hemorrhage into the mouth or nares, should be excluded as being a gastric symptom, merely mechanical and only indirectly connected with the cranial or intracranial injury. With this proper limitation vomiting occurred in about 13 per cent. (132) of the total number of cases, usually very soon after admission to the hospital or even earlier, but occasionally delayed for a number of hours. It sometimes occurred but once, and sometimes continued even till the following day. The matter vomited was most frequently undigested food, occasionally with a little admixture of blood which in other cases gave a brownish tinge to a mixture of bile and gastric fluids. It was profuse or scanty according to the amount of food the stomach happened to contain. It was not often associated with symptoms of general shock, nor in a majority of cases with a subnormal temperature. It occurred in a rather larger percentage of cases with the much smaller number of children injured than with adults. In short, it had no special characteristics which distinguished it from vomiting under any other circumstances. Its chief importance seems to reside in the fact that it has been counted among the diagnostic symptoms of so-called concussion. It is unnecessary to

confront this symptom in detail with the lesions with which it has been found to be associated. In the twenty cases in which opportunity was afforded for post-mortem inspection the lesions in each instance were markedly severe, and as in case of asymmetrical pulse, abnormal pupil and loss of sphincteric control, it represented all forms of intracranial hemorrhage and contusion, and involved all intracranial regions. There is no reason to doubt that like them it is a result of disturbance of the sympathetic system of nerves. It is associated with no special intracranial injury, has no distinctive characteristics, and is entirely independent of volition. It differs in no respect from vomiting induced by any other form of sudden injury, or by mental shock or violent emotion.

The occurrence of chill or of a profuse perspiration is too infrequent, and of too little apparent significance to justify more than brief remark. Two cases in which there had been a chill were subjects of necropsy. Symptoms had been diverse, but in each cerebral œdema and hyperæmia were excessive, with a large pial hemorrhage in one and a large epidural hemorhage in the other. As similar conditions are habitually observed without the chill, there is no reason to suppose a special relation to exist between them in these very exceptional instances.

Chill, like vomiting, is not an unusual indication of any severe shock mental or physical, sustained by persons of susceptible nervous organization. Perspiration more or less profuse, occurring in rare instances as a primary or later symptom, has no greater significance. It is a simple trophic disturbance with which the cerebral nervous system can have no more intimate connection than when it occurs under other and more ordinary circumstances.

Headache and vertigo belong to another category of symptoms. They are the result of the meningeal or cerebral circulatory derangement, and in nowise differ in character from the same symptoms as they attend similar derangements following indigestion, a febrile action, or other morbid state. As circulatory conditions are always altered in case of intra-

cranial injury, headache is naturally one of its frequent indications, and usually denotes hyperæmia. Vertigo is less frequent and is oftener the result of anæmia. Headache has no further significance. It may be early or late, intense or moderate in degree, general or localized; but aside from certain cases of cranial fracture does not point to the site, severity, or nature of the lesion.

Vertigo as a focal symptom from injury of the eighth nerve will be found in a number of the cases of fractured base with hemorrhage from the ear.

VIII.—Muscular Disorders.—The muscular disorders were both local and general. Their character, and comparative frequency in fatal and recovering cases are shown in their classification:

Convulsions:

Fatal cases	75
Recovering cases	35
	110
Necropsies	50

Convulsive Movements and Minor Muscular Contractions:

Fatal cases	56
Recovering cases	24
	80
Necropsies	44

Muscular Rigidity:

Fatal cases	101
Recovering cases	29
	130
Necropsies	71

PARALYSIS.

General:

Fatal cases	6
Recovering cases	2
	8
Necropsies	6

Paraplegia:
Fatal cases 1
Recovering cases 2
3
Necropsies 1

Hemiplegia:
Fatal cases 44
Recovering cases 24
68
Necropsies 27

Upper Extremity:
Fatal cases 10
Recovering cases 14
24
Necropsies 6

Lower Extremity:
Fatal cases 2
Recovering cases 0
2
Necropsies 2

Face:
Fatal cases 30
Recovering cases 31
61
Necropsies 18
Ocular Muscles 50
(Approximately)

The actual percentage of cases characterized by derangements of muscular action is somewhat less than that indicated in these tables, since in at least one hundred, two or more co-existed in the same individual.

Convulsions, Convulsive Movements, and Muscular Rigidity.—When the present series of 1000 cases was examined in blocks of 100 some remarkable variations were observed in the comparative frequency with which convulsions

had occurred. The average number of cases was 10 and a fraction for each 100; but while in the fourth hundred there were 19, in the eighth there were only 3, and in the ninth again there were 12. This is important only as showing the absolute necessity of statistics being compiled upon a large scale if they are to be of value. Similar discrepancies have been often noted in the comparison of other conditions when they have been studied in the same numerical subdivisions.

The conditions which may predispose to convulsive attacks in cases of intracranial injury do not seem to be largely operative. The most important is sex. Nine only of the 110 cases observed were of females, and the importance of a large aggregate of cases for statistical deduction is again evident in the fact that but one of these occurred in the last 500 cases. Three of the 9 were young children, and 3 were suffering from alcoholic excess.

The relation of age to frequency, and to prognosis, may be best shown in tabular form.

	Cases.	Recovered.	Died.
From 2 months to 8 years	19	6	13
From 10 to 20 years	13	5	8
From 20 to 30 years	23	12	11
From 30 to 40 years	19	4	15
From 40 to 50 years	14	3	11
From 50 to 60 years	16	1	15
At 70 years	1	1	0
	105	32	73
Adults—age not specified	5		
	110		

The 19 cases in infants and young children were all that occurred in a total of 102 instances of intracranial injury in children, three-fourths of whom were less than 7, and none more than 10 years of age. Simple convulsive movements occurred with about the same frequency. It is apparent from these figures that early childhood, not less than womanhood resists, rather than predisposes to, convulsive attacks—con-

trary to what might have been anticipated from their greater susceptibility of nervous organization.

The rate of mortality was high at all ages, and in children was 70 per cent. as against 21 per cent. with intracranial injuries when this complication did not exist.

Five cases at least were those of epileptic patients who had received their injury from falling while in a paroxysm; and others who were known epileptics. Two had suffered from epileptiform attacks resulting from previous traumatism.

Several of these patients were admitted to the hospital in an intoxicated condition, and many doubtless were habitual inebriates; but as at least an equal proportion of those who had no convulsions had a similar record there is no reason to suppose that the alcoholic habit or condition was influential in producing the paroxysms. It seems probable that aside from sex there is no predisposing circumstance greatly affecting the operation of the direct cause resident in the intracranial lesion. The reason for the comparative exemption of women is not apparent.

Post-mortem examination discovers no focal lesion which can be held responsible for these violent muscular disturbances. Even when unilateral the attendant lesions disclosed are multiple; and so far as they are limited may equally appear upon the same or upon the opposite side of the brain. There is, however, a demonstrable relation between the lesions and the convulsive disorder. In almost every instance both the cerebral cortex, or its meninges and the subcortex are involved. Dural wound or inflammation, pial contusion indicated by thickening, adhesion, infiltration or subarachnoid effusion, acute or subacute arachnitis; cerebral contusion or laceration with cortical hemorrhage; one or more were present in every case save one; and in that an enormous epidural hemorrhage closely compressed the cerebrum and its membranes upon the inner cranial surface. In 10 cases there was no laceration involving the subcortex; but in each there was other deep seated lesion of importance—either excessive hyperæmia and œdema, or sclerosis. In a possible exceptional case an

acute arachnitis was alone noted. The lacerations in all but 5 cases involved the temporal or frontal lobes or the optic thalamus; 3 were limited to the anterior parietal, and 2 to the occipital region. It was also the anterior parietal region which was lacerated in the few cases in which the parietal was involved with the temporal or frontal lobe.

It may be assumed therefore with considerable confidence, though not with certainty, that when convulsions occur there are both superficial and deep intracranial lesions and that the limited lesion is confined to the anterior region of the brain or involves an optic thalamus.

Simple convulsive movements are so closely allied to typical convulsive paroxysms that no distinctive differences can be supposed to exist in their underlying lesions. In a post-mortem examination of 30 cases in which such movements had been uncomplicated by other muscular disorders, it was found that in 50 per cent. there was no laceration, and that in a considerable number of others an epidural hemorrhage as the most important superficial lesion replaced the subdural pathological conditions noted when paroxysms had been complete. In general the lesions had been no less severe or complicated.

Convulsions were usually epileptiform in character, and when epileptic were probably in subjects of previous epileptic habit. They were unilateral in 10 cases, were confined to the face and upper extremities in 2, and were general in the remaining 98. They were primary in 67, and secondary in 43; they occurred as a single attack, or when multiple recurred in rapid succession or after an interval of many days. They were variously preceded, accompanied, or succeeded by muscular rigidity, paralysis or other symptoms of intracranial injury, as might be expected from the multiplicity of attendant lesions.

Convulsive movements were observed under all possible conditions. They occurred in all regions of the body including the face and extremities, involving all the muscles of a part or limited to groups or even to individual muscles. It is impos-

sible to ascribe to them definite relations to other general symptoms by which they were accompanied.

Muscular rigidity, like simple clonic muscular contractions, occurred either by itself or as an accompaniment or precursor of other abnormal muscular conditions. Like the clonic contractions it was general or limited, early or late in its manifestation, transient or permanent, and of a greater or lesser degree of intensity. Unlike the localized clonic contractions, which often terminated in a general convulsion, it did not tend to a general tonic spasm.

A general pial or cortical hemorrhage or subarachnoid serous effusion in many cases attended general rigidity or convulsive movements; and less often a local lesion corresponded to a limited muscular disturbance; but the exceptions to such a correspondence were too numerous to permit its acceptance as a general rule. The following instances will serve as illustrations:

1. *Cervical Rigidity*—noted on third day.

Lesions: Epidural and pial hemorrhages in right middle basal fossa; subarachnoid effusion confined to vertex; general cerebral hyperæmia and œdema.

2. *Cervical, Followed by General, Rigidity.*—Cervical rigidity on the fourth, with rigidity of upper and lower extremities on the fourteenth, and increased cervical rigidity on the twenty-first day.

Lesions: Laceration of the inferior surface of left frontal lobe with large cortical hemorrhage in anterior and middle basal fossæ; moderate subarachnoid effusion at vertex; none at base.

3. *General Rigidity.*—Primary general convulsive movements followed by a general spastic condition of the muscles.

Lesions: Limited cortical laceration and contusion of right temporal lobe, with cortical hemorrhage in all the right basal fossæ.

4. *General Rigidity.*—Primary; more marked on right side.

Lesions: Small epidural hemorrhage over left frontotemporal junction; laceration of first and second left temporal convolutions with cortical hemorrhage limited to the temporal (lobe) region.

5. *Rigidity of Right Arm and Leg.*—Primary.

Lesions: Epidural hemorrhage over left, and pial hemorrhage over right temporal lobe; contusion of all the right temporal convolutions; small amount of serum in each lateral ventricle.

6. *Rigidity of Left Arm and Leg.*—Primary; later the left extremities became restless; the right extremities remained motionless.

Lesions: Subacute arachnitis confined to posterior parietal and occi-

pital regions; slight pial hemorrhage upon left inferior cerebellar surface; limited contusion of fornix posteriorly; excessive general hyperæmia and œdema.

7. *General Rigidity:* Manifested on eighth day; most pronounced in right upper extremity.

Lesions: Decolorized thrombi in both lateral and both inferior petrosal sinuses; entire brain, including cerebellum and basal ganglia, hyperæmic with moderate œdema.

8. *General Convulsive Movements:* at end of first day.

Lesions: Moderate subacute meningitis with serous effusion limited to right parietal region; purulent effusion at base; limited cortical contusion of left temporal lobe; excessive cerebral hyperæmia and œdema.

9. *General Convulsive Movements.*—Primary; gunshot wound.

Lesions: Ball passed through right hemisphere anteroposteriorly on a plane slightly above the corpus callosum.

10. *General Convulsive Movements.*—Primary and strongly marked, involving various sets of muscles.

Lesions: Epidural hemorrhage from rupture of left sigmoid sinus; pial hemorrhage over left parietal lobe; cortical contusion of left temporal lobe.

11. *Convulsive Movements of Right Side and Rigidity of Left Side.*—Both conditions primary and strongly marked.

Lesions: Epidural hemorrhage covered whole lateral surface of right hemisphere and to within one inch of median fissure. Cortical hyperæmia; slight contusion of second left temporal convolution.

12. *Convulsive Movements of Both Arms.*—Primary.

Lesions: Cortical hemorrhage over inferior surface of both frontal lobes, and over superior surface of cerebellum; laceration of inferior sur face of left frontal lobe; subcortical contusion of anterior portion of right optic thalamus with punctate extravasations and of pons in transverse fibres; moderate cerebral hyperæmia and œdema.

13. *Single General Convulsion:* Preceded by left hemiplegia, and accompanied by rigidity of left upper extremity on the fourth day.

Lesions: Four areas of meningeal contusion; one over each frontal lobe and one over each parieto-occipital junction; each about two inches in diameter with subarachnoid serous and hemorrhagic effusion; small contusion of right temporal lobe; subcortical excavation of both frontal lobes extending into right motor area.

14. *Multiple General Convulsions.*—Seven convulsions on the second day, preceded on the first by convulsive movements.

Lesions: Extensive laceration of left temporal lobe, and cortical hemorrhage in middle and anterior basal fossæ; blood in great part had escaped through cranial fissures into tissues about the eye.

15. *Unilateral Multiple Convulsions.*—Primary; began in face; tonic preceded clonic contractions.

Lesions: Direct laceration of dura and pia mater and lateral surface of right temporal lobe at point of fracture; cortical hemorrhage in right middle and posterior basal fossæ.

It is evident from these illustrations, which might be very greatly extended, that while a meningeal or cortical lesion almost invariably exists, and is usually associated with one more deeply seated, both tonic and clonic muscular contractions are independent of the exact site or nature of lesion. The occasional instances in which the motor zone is directly affected by gross injury or pressure are but accidental; and even when this area is involved it is usually by a hemorrhage or subarachnoid effusion insufficient in amount to be of much apparent importance in explaining the muscular disturbances as of focal origin. The extreme frequency of lesion of a temporal lobe is worthy of note.

Paralysis.—Traumatic differ from idiopathic paralyses only in their origin and in the nature of their lesions. General paralysis and paraplegia, however, are so infrequent in the course of intracranial injuries as to justify some special reference to the history of such as are included in the present series of cases.

General Paralysis.—One of the eight cases noted evidently resulted from a coincident injury of the spinal cord, and the patient was discharged from the hospital on the twenty-second day with incomplete recovery. In a second case the patient survived under observation for six months. He had jumped from a ship's deck to a raft alongside, a distance of twenty-five feet, and was at once admitted to the hospital with left hemiplegia and paresis of the right upper extremity. He was later generally hyperæsthetic with the exception of the left leg which was anæsthetic. The still later symptoms included those referable to lesion of the left prefrontal region which continued, together with the loss of power in the paralyzed leg, at the time of his discharge from the hospital.

The six cases remaining were all fatal, and the relation of muscular conditions to lesions were as follows:

CASE LXI.—Manner of injury unknown; patient unconscious; left pupil dilated and both pupils without reaction; respiration shallow; total paralysis.

Lesions.—Fracture extending from torcular herophili to foramen magnum; pial hemorrhage filling both posterior and basal fossæ; general cerebral contusion with œdema and much serous effusion in both lateral ventricles. Died in ambulance.

Case LXII.—Patient fell fifteen feet, striking her head upon the pavement; unconscious; primary right hemiplegia, and paresis of left side and right face; both patellar reflexes lost; respiration ceased abruptly; cardiac pulsations continued for an appreciable interval. Died in twenty-four hours.

Lesions.—Fissure extended from left inferior parietal region through petrous portion into middle basal fossa; large subcortical excavation of left temporal lobe; blood breaking through the cortex at one point from which a thick clot extended over the anterior part of the lobe and in a thin sheet covered the whole left frontal and parietal lobes and anterior part of left occipital lobe. Blood had also flowed from the left temporal region through the Sylvian and median fissures and formed a thick clot over the pons and medulla; moderate cerebral hyperæmia and œdema.

Case LXIII.—Patient fell down one flight of stairs; coma; pupils dilated and irresponsive. Paralysis general. Died in eight hours.

Lesions.—Fracture extending from right occipital inferior curved line across petrous portion, and into sella turica; laceration of inferior surface of right temporal and frontal lobes; cortical hemorrhage filling right anterior and middle basal fossæ, and extending in a thick clot over frontal lobe and into median fissure; large pial hemorrhage covering superior surface of both hemispheres; hyperæmia and punctate extravasations throughout the brain.

Case LXIV.—Patient struck upon the head with a club; a little later sudden loss of consciousness with general slight convulsive movements which soon ceased, but recurred two hours afterward; immediately followed by general paralysis, including both sides of the face with divergent strabismus. Died in twelve hours.

Lesions.—Fine fissure extending from mid-frontal region into left middle basal fossa; pial hemorrhage thickly covering left hemisphere and forming a thin sheet upon inferior surface of cerebellum; no lacerations; minute contusions of right temporal,

and inner border of left temporal lobe and of first orbital convolution; moderate hyperæmia and excessive œdema of all parts of the brain.

CASE LXV.—History unknown; coma; respiration at times irregular; paralysis of both upper, and paresis of both lower extremities; general impairment of sensation; slight movement of fingers and of right wrist; patellar reflexes absent. Died on third day.

Lesions.—Fracture extending from right temporal bone into foramen magnum; epidural hemorrhage in a thick clot flattened right vertex and extended to base; no lacerations; general cerebral hyperæmia and œdema.

CASE LXVI.—Patient jumped from the third tier of the Tombs prison to the flagging below; various signs of intracranial injury but no muscular disorders until the sixth day when all the extremities became paretic, most markedly on the right side, with impaired sensation; some right facial paralysis two days later; general paralysis continued until death on the sixteenth day.

Lesions.—Fracture extending from left squamous portion of temporal bone along anterior surface of petrous portion into optic foramen; slight lacerations of right temporal lobe with cortical hemorrhage extending from occipital lobe forward and barely reaching to motor area; intense cerebral hyperæmia; excessive cerebral œdema, serum following the knife on section; ventricles distended.

The first and second of these cases are readily explicable by a possible flow of blood from the posterior basal fossæ into the spinal canal, and the third by a compression of both motor areæ by a pial hemorrhage. The other three are less readily comprehensible. One motor area only was compressed in the fourth and fifth cases; and in the sixth, as well as in the fourth and fifth, cerebral œdema was excessive.

Paraplegia.—The instances of paraplegia were but three in number, and the only one which was fatal afforded upon necropsy no positive results. Death occurred five minutes after admission to the hospital. The lesions were: Fracture extending from left posterior parietal region into the anterior

and middle basal fossæ; epidural hemorrhage, still fluid, extent not noted; slight hemorrhagic extravasations into the meshes of the pia mater; and slight lacerations of the inferior surface of the left temporal and frontal lobes.

The cases of recovery were:

CASE LXVII.—Trifling scalp wound in left mid-parietal region near the median line with a large hæmatoma, variously accounted for by the patient who was sure he had been struck, but was uncertain whether by a railroad bridge, or by a bootblack; complete paraplegia the only general symptom; reflexes slightly exaggerated; muscles flaccid; no previous paralysis; no history of syphilis; treated with potassium iodide. He was able to walk fairly well after one week.

CASE LXVIII.—Patient six years of age had been struck by a box falling from a distance; unconscious; compound fracture of vertex with epidural hemorrhage; paraplegia on the fifth day. Sensation unimpaired; reflexes normal; highest temperature 100.2°; he could walk a little with support on the forty-fifth day.

Paralysis of One Lower Extremity.—Necropsy was had in both the two cases noted. In one of these, patches of lymph were deposited over both margins of the median fissure, and may perhaps afford adequate explanation of the paralysis which occurred on the fifteenth day after injury; in the other case, one in which there was paralysis of the left lower extremity, the lesions were: Fracture extending from the left squamous portion through the left middle and both anterior basal fossæ; a large epidural clot in the left middle fossa, and a general cerebral contusion.

Paralysis of the Upper Extremities.—While the instances of a paralysis confined to one or both the upper extremities were more frequent than paralysis of a single lower extremity, their percentage was still small. They were 24 in all, of which 10 were fatal and 6 were subjected to a post-mortem examination. They were primary or secondary in equal number, and were oftener incomplete than complete. They were of both transient and permanent duration and were variously complicated or uncomplicated by disorders or losses of sensation.

The lesions noted at necropsy were:

1. Primary paralysis and anæsthesia of the left upper extremity—preceded by convulsive movements for five minutes.

Epidural and cortical hemorrhage over whole left hemisphere; cortical hemorrhage over right motor area; marked cerebral hyperæmia; extensive lacerations of right frontal and temporal lobes.

2. Paralysis of right upper extremity on the fourth day.

Epidural clot compressing and flattening the whole left hemisphere; laceration of the left temporal lobe; lateral ventricles distended with serum, each to the amount of two ounces; and *iter e tertio ad quartum ventriculum* distended to size of goose quill; small hemorrhage in floor of fourth ventricle.

3. Paralysis of left upper extremity on the second day.

Large cortical hemorrhage over right temporal lobe, and in thick clot over upper part of fissure of Rolando; general cerebral hyperæmia with minute thromboses; thrombus in lateral sinus.

4. Primary paralysis of right upper extremity preceded by anæsthesia; both disappeared within twenty-four hours.

Moderate subarachnoid effusion; subcortical excavation of whole left frontal lobe with blood breaking into the lateral ventricle; subcortical excavation of right frontal lobe with blood breaking through the cortex; deep laceration of posterior border of the cerebellum, brain hyperæmic and œdematous; minute vessels filled with coagula.

5. Paralysis of right upper extremity on second day, with rigidity of both arms and right leg.

Epidural clot compressing left hemisphere and extending from Sylvian to median fissure; entire brain excessively hyperæmic.

6. Paralysis of right upper extremity on the ninth day preceded by general muscular rigidity and convulsions, and accompanied by slight right facial paresis.

Large arachnoid serous effusion; thin pial hemorrhage covering both parietal and both occipital lobes; small lacera-

tions of right frontal and left occipital lobes; general cerebral hyperæmia and œdema, with minute thromboses, punctate extravasations, and serous fluid in left lateral ventricle.

In each instance but one, and possibly in that one the motor area of the opposite side was covered by blood or a serous effusion; but the amount of pressure exerted, or its sufficiency as the cause of the paralysis is uncertain.

Hemiplegia.—Cases of hemiplegia were usually complicated by other muscular disorders. These were:

	In fatal cases	In recovering cases
Convulsions	7	4
Facial paralysis	10	8
Convulsive movements	10	3
Muscular rigidity	8	5
No muscular complications	9	4
	44	24

The accessory muscular disorders were general, or were limited to either the hemiplegic or opposite side, and were in varying degrees prominent in the history of the case.

The hemiplegia which, as in idiopathic cases, might be either suddenly or progressively developed and might be either a complete or an incomplete loss of muscular power, was primary in 27 fatal, and in 12 recovering cases; and was secondary in 17 of those which were fatal and in 12 of those which recovered.

Anæsthesia was concurrent in 7 fatal and in 2 recovering cases.

Destruction of the optic thalamus was undoubtedly responsible for the occurrence of hemiplegia in 2 cases, and compression of the motor area by blood or inflammatory exudation seems adequate explanation in 10 others of the 27 in which post-mortem examination was made. In 6 of the cases remaining a similar compression was possible; in 3 the notes of necropsy were deficient; and in 6 no gross lesions of the motor area or motor tract existed.

The lesions in the cases last mentioned were:

1. Right primary hemiplegia. Laceration of external border of right cerebellar lobe with cortical hemorrhage about the circle of Willis, upon the anterior portion of the pons and in the transverse fissure; hemorrhage (apoplectic) in the left lateral ventricle, breaking into the right ventricle and into the left occipital lobe which it completely excavated.

2. Left secondary hemiplegia. Subarachnoid serous effusion limited to frontal regions; excessive cerebral hyperæmia with minute thromboses.

3. Left secondary hemiplegia. Excessive meningeal and cerebral hyperæmia with minute thromboses.

4. Left primary hemiplegia. Cortical hemorrhage over left hemisphere from laceration in posterior parietal region.

5. Left primary hemiplegia. Pial hemorrhage in posterior basal fossæ and in right lateral ventricle.

6. Left primary hemiplegia. Pial hemorrhage over left hemisphere; subcortical laceration of right posterior inferior portion of parietal lobe, and of first and second right temporal convolutions, from which blood had escaped into the right ventricle.

Facial Paralysis.—Facial paralysis was somewhat less frequently complicated by other muscular disorders than hemiplegia; but was equally varied in its manifestations. It was fatal or recovering, and was primary or secondary in nearly equal proportions. It was variably general, or confined to either the upper or lower face area, was transient or permanent, was slight or complete, and was as devoid of special peculiarities as are all other forms of traumatic paralysis. It was associated with general paralysis in 1 case, with general convulsions in 11, with hemiplegia in 11, and with paralysis of an upper extremity in 7 cases. It was double in only 2 instances, and was not often accompanied by simple convulsive movements.

Necropsy was had in 18 of the 30 fatalities, but in 2 the notes are missing. In 6 of the remaining 16 cases there were other paralyses in connection with which they have been given consideration. In 3 of the final 10 cases in which paralysis

was facial alone there were no gross lesions of the face centre, motor tract, or facial nerve.

The lesions noted in these cases were:

1. Incomplete right facial paralysis. Epidural hemorrhage in right midfrontal region in an area of about 2 x ¾ inches; cortical laceration of inferior surface of both prefrontal lobes and of left temporal lobe; marked general hyperæmia, especially of the cortex, and moderate œdema.

2. Right facial paralysis. Epidural hemorrhage in right parietal and occipital regions; cortical hemorrhage in both superior occipital regions; both hemorrhages in moderate amount; laceration of inferior surface of both frontal lobes anteriorly; brain excessively hyperæmic and œdematous.

3. Right lower facial paralysis, manifested on the sixth day. Small epidural hemorrhage limited to left prefrontal region; laceration of inferior surface of both frontal lobes, mainly subcortical; general cerebral hyperæmia, with minute thrombosis, especially in the occipital region.

The frequency of injuries of the temporal lobe is as noticeable in case of the various paralyses as it was in case of muscular rigidity and convulsive movements already mentioned. In the several instances of serious lesions of an optic thalamus it is perhaps probable that the inner capsule was involved.

Disorders of the Ocular Muscles.—These occurred in about equal number in fatal and in recovering cases. They included exophthalmos, convulsive movements, conjugate deviation, general paralysis of the ocular muscles, ptosis and strabismus. They were noted in 15 cases. These were:

1. Four cases of exophthalmos, 3 with fracture through both anterior fossæ and hemorrhage into the orbit, and 1 without fracture, which was slight and unilateral, with ecchymosis of the upper lid and a large hæmatoma in the temporal region of the corresponding side.

2. Two cases of convulsive movements; 1 occurring *in articulo mortis,* following general convulsions, and the other paroxysmal, confined to one eye, and accompanied by convulsive movements of the upper extremity of the same side.

There was nothing to suggest that these differed from those cases marked by similar movements in other limited groups of muscles. The obvious essential lesion in one instance was an epidural hemorrhage, and in the second, a special hyperæmia of one optic thalamus.

3. Six cases of conjugate deviation. The muscular conditions and lesions in these cases were:

a. Eyes turned upward and to the right; on the second day slight convergent strabismus. *Lesions:* Dura mater greatly congested in its posterior two thirds; longitudinal sinus containing white clots in its anterior half, and in its posterior half filled with red coagulum; acute arachnitis with seropurulent effusion at the vertex and thick pus at the base; fracture through middle and posterior basal fossæ.

b. Eyes turned to right and fixed in tonic spasm; later, spasmodic contractions of various groups of muscles. *Lesions:* Large epidural hemorrhage from rupture of the sigmoid sinus; pial hemorrhage over right parietal lobe extending from fissure of Sylvius upward; contusion of third left temporal convolution; linear fracture, 8 inches long, immediately in front of coronal suture, with depressed fragment 1½ inches square, involving both right frontal and right parietal bone; comminuted fracture at left parieto-occipto-squamous junction with fissures extending into middle and posterior fossæ and intervening petrous portion.

c. Eyes turned to right; slight general convulsive movements. *Lesions:* No lacerations or intracranial hemorrhages; moderate subarachnoid serous effusion in right parietal region; purulent effusion in moderate amount over anterior border of the pons, posterior border of the cerebellum, and posterior portion of the inferior cerebellar surface; cortical contusion, 3 x 2½ inches in extent, embracing middle portion of first left temporal convolution and adjacent parietal surface; excessive cerebral hyperæmia and œdema with serous effusion in the lateral ventricles; fracture extending through petrous portion into right middle and posterior fossæ.

d. Head and eyes turned to the right; convulsive move-

ments of left angle of mouth, and of right hand and arm. *Lesions:* No fracture; no lacerations; pial hemorrhage covering whole brain except frontal lobe; thickest in right middle and posterior parietal regions; was both above and below the tentorium; general cerebral hyperæmia and œdema.

e. Head and eyes turned to the right; left facial paralysis; slight twitching of the fingers of the right hand. *Lesions:* Inconsiderable pial hemorrhage over left fissure of Rolando; laceration of whole lateral surface of right temporal lobe, except at its tips, and of a narrow margin of its periphery; cortical hemorrhage which escaped through a wound in the dura mater and formed an epidural hemorrhage over the right temporal and posterior part of the right frontal lobe; cerebral thrombi and punctate extravasations; diastasis of left corneal suture.

f. Head and eyes turned to the left; left hemiplegia. *Lesions:* "Hemorrhage into the ventricle and around the bulb"—(Note made by coroner).

g. Head and eyes turned to the right; left hemiplegia. *Lesions:* Small epidural hemorrhage—about one drachm—in right middle fossa; subarachnoid serous effusion; general cerebral hyperæmia and œdema.

These post-mortem findings differ from those found in the more frequently reported cases of idiopathic origin. Those have been almost if not quite invariably gross structural changes in the brain tissue, the result of softening, cerebral hemorrhage, or morbid growth. These, so far as they were cortical or subcortical, were generally the hyperæmia and œdema common to all intracranial injuries. The more obvious lesions were superficial, the meningeal hemorrhages and inflammatory effusions. There were 2 cases of limited contusion of a single temporal convolution and 1 of a wide laceration of a temporal lobe; neither of these encroached upon the recognized motor centres for the head and eyes; and it is doubtful if those centres were compressed by either of the superficial hemorrhages or effusions.

4. One case of ptosis; accompanied partial loss of vision

in the corresponding eye and total loss in the other; and resulted from a gunshot wound in which the ball passed between the periosteum and orbital plates. (Other cases were included in facial paralysis.)

5. One case of strabismus; accompanied general, including double facial paralysis. (See General Paralysis.)

General paralysis of the ocular muscles was only observed in recovering cases. These were three in number.

CASE LXIX.—*Fracture of the cranial base,* followed by a purulent discharge from the right ear and symptoms of arachnitis; no injury in orbital regions; left pupil continuously more or less widely dilated and irresponsive paralysis of all the muscles of the left eye, and paresis of those of the right; left facial paralysis.

CASE LXX.—Patient fell down stairs headforemost; profuse epitaxis; much ecchymosis of both upper eyelids; pupils normal; diminished facial sensibility. Eight hours later, intense headache and diplopia. Fifth day: Exophthalmos of left eye, from paralysis of all the ocular muscles; optic neuritis in both eyes; impaired sensation in the course of distribution of the first and second divisions of the fifth nerve on the left side. Headache and diplopia disappeared in a week's time.

A third case is detailed in another connection.

A very large number of cases of paralysis have been cited in order that the correctness of the conclusions which they suggest may approach a mathematical demonstration.

An examination of the lesions of all forms of paralysis has shown a certain number of cases of unmistakable compression of the motor area or laceration of the motor track. It has also shown many others in which such injuries seem probable, as well as a still greater number in which they may have been possible. There has remained a considerable number of cases in which no focal lesion is apparent, and of which the interpretation must be in some degree conjectural. The lesion in these cases must be by exclusion a general lesion and therefore necessarily a contusion of the brain substance. The primary result of cerebral contusion as already noted is an

anæmia followed by a hyperæmia from which, it has been demonstrated, there result nutritive changes indicated by œdema and cellular degeneration. In view of these pathological facts it is not difficult to understand the occurrence of a loss, impairment, or disorder of muscular function even in the absence of gross lesion of the motor centres. Nerve fibres or nerve cells may suffer either from the intracerebral pressure of distended veins or serous transudation, or from the degenerative processes.

While in the many instances in which the indirect pressure of an inconsiderable epidural hemorrhage, or the more direct pressure of a thin pial or cortical hemorrhage or moderate subarachnoid effusion, exerted upon the motor area may conceivably occasion a concurrent paralysis, it still seems more reasonable to suppose that as in the cases in which no such conditions exist it is independent of the superficial lesion.

It is difficult to explain the limitation of paralysis to a single extremity or to individual muscles when the whole cerebrum is laterally compressed by a large epidural hemorrhage, or when the whole motor area is uniformly covered by a subarachnoid effusion. It becomes more comprehensible, however, upon the supposition that the superficial pressure primarily affects the cerebrum as a whole; and that a resulting irregular general circulatory derangement and degenerative nutritive changes have a local manifestation in the corresponding cells or projection fibres.

Ataxia.—There was only one instance of ataxia noted; this was of the motor form and was in a case terminating in recovery. The patient, who had fallen from a truck and struck upon the back of his head, was primarily delirious and afterward slow of comprehension. He suffered much from occipital headache, and ocular examination disclosed advanced optic neuritis in the right eye with slight paralysis of the external rectus muscle. His temperature did not exceed 101° and his respiration was 12 in the minute for three days, normal for six days, and then 8 to 12 for two weeks with normal temperature. He was out of bed at the end of the third week,

but walked with difficulty on account of muscular inco-ordination equally marked in both legs. The patellar reflexes were normal. He had no other symptoms except slight vertigo and some slowness of comprehension.

In one instance also there was some lack of co-ordination in the finger muscles. In this case there was a superficial parietal abscess just posterior to the motor area, and a general acute arachnitis.

Disorders of the Cutaneous, and Muscular or Tendinous Reflexes.—These disorders have no diagnostic importance. They were noted in about 15 per cent. of cases, and would probably have been found in much larger proportion if they had been sought in all cases, not only primarily, but throughout their progress. They occurred in the various modifications of normal conditions observed under other circumstances, and were not apparently influenced by concurrent symptoms, nor dependent upon the nature of attendant lesions. An analysis of 32 cases with necropsy occurring in the last 300 of the series afforded results which may be considered representative of all such cases.

Reflexes Increased	10
Patient unconscious	6
Patient conscious	3
Patient delirious	1
Concurrent muscular disorders	6
Reflexes Absent	16
Patient unconscious	12
Patient conscious	3
Patient delirious	1
Concurrent muscular disorders	8
Reflexes Unsymmetrical	6
Patient unconscious	3
Patient conscious	2
Patient delirious	1
Concurrent muscular disorders	2

It may be noted that neither the mental nor the general muscular condition greatly affected the nature of the reflex

disorders. The muscles were rigid, convulsed or paralyzed, and the patient conscious or unconscious, in about the same proportion of cases whether the reflexes were lost or increased. They were paralyzed in only 5 instances, 1 of the face and 4 of hemiplegia.

The most careful examination post mortem fails to disclose any definite relation between evident lesions and the reflex phenomena. Large cortical and meningeal hemorrhages were rather disproportionately frequent; but meningeal contusion or inflammation, and subcortical without superficial lesion were also encountered; and all of these without reference to the particular reflex condition. The motor tract or area was not often specifically involved.

IX. Focal Symptoms.—Focal symptoms are referable to lesions of cranial nerves or of cerebral centres of control.

Cranial Nerves.—Such symptoms may be occasioned by lesion of the nerve at its origin, in its intracranial course, or at its cranial exit; and are manifested in functional loss or derangement.

Lesions of the olfactory nerve or bulb, or of its central origin occurred in nine cases, in all of which with possibly a single exception in which the method of examination is not stated, the effect of simple sensory irritation was carefully excluded. In each case but one the cranial base was fractured, and in all save one the patient recovered; but the special sense was not restored in either while under observation. In four cases the left frontal lobe was also injured.

CASES.

Case LXXI.—The patient lived one week after having been assaulted, all the time delirious and incapable of exhibiting subjective symptoms.

Lesions.—No epidural hemorrhage or meningeal effusion; extreme meningeal and cerebral contusion; laceration of left frontal lobe; right olfactory bulb disintegrated and involved in cortical clot; left bulb distended by internal hemorrhage.

Case LXXII.—Gunshot wound through right temporal fossa;

primary loss of the special senses of sight and smell; progressive exophthalmos. The eye was removed on the fifteenth day and the bullet found in the inferior portion of the right frontal lobe; middle basal fossa and orbital wall comminuted.

CASE LXXIII.—The patient was thrown from a high cart and struck the ground upon the back of her head. She was primarily unconscious, and suffered a contusion of the right occipital region attended by severe localized pain and mastoid ecchymosis. Hearing was disordered until the fourth week. The special senses of smell and taste were primarily impaired and two years later were unimproved.

CASE LXXIV.—A physician in a railway accident received a contusion of the right parietal region. Two days later symptoms appeared which still persisted after the lapse of several years. They were: dilatation of the left pupil with incomplete paralysis of all the left ocular muscles and levator of the upper eyelid; anæsthesia of the conjunctiva of the left eye and mucous membrane of the left nostril; complete loss of the sense of smell in the same nostril; excessive pain on the left side of the head and face in the course of distribution of all the branches of the fifth nerve.

Loss of sight so far as it depends upon implication of the optic nerve in a line of fracture through the optic foramen was noted in connection with the symptomatology of fracture; and some account given of the six cases observed. In a seventh case the loss of sight was evidently from intracranial injury, either of the optic nerve or in the course of the optic tract. The loss was not discovered until the fifth day and was temporary. The pupils were symmetrical and the optic disc was practically normal.

The paralysis and disorders of the ocular muscles from lesions of the third, fourth and sixth nerves, or of the brain itself, were described and illustrated in the consideration of muscular disorders in general. A case not cited in that connection is noted for the strict confinement of lesions to these nerves.

CASE LXXV.—A man while dancing fell backward, striking his head upon the ballroom floor. He had no symptom of injury

except a slight headache for thirty minutes. His right eyelid then began to droop, and ptosis was soon complete. Examination was made five hours later. There was no wound or evident contusion; ptosis of the right eye was still complete with external strabismus; there was also incomplete paralysis of all the right ocular muscles, diplopia and imperfect accommodation. The pupils and retina were normal, and there were no other symptoms then or thereafter.

Although some degree of facial paralysis is of frequent occurrence, its dependence upon lesions of the facial nerve is not often demonstrable. In one case only of the present series there was obvious compression of the nerve in its osseous course of exit; in this the bone was comminuted and the aqueductus Fallopii filled with clot. Fractures of the petrous portion are usually simple fissures without displacement; and facial like ocular paralysis seem to be the result of central lesion.

There was no instance in which disturbance of function of the fifth nerve was an independent focal symptom. In two cases of anosmia the sense of taste was lost or impaired, and in a third pain persisted in the course of distribution of its sensitive fibres. There was no case in which the muscles of mastication were affected, and very few in which facial paralysis was accompanied by anæsthesia.

Deafness resulted in many of the cases in which fracture through the petrous portion was attended by hemorrhage from the ear. It was doubtless often due to rupture of the tympanum and obstruction of the auditory canal; but in a certain number of cases it is fair to assume that the distribution of the auditory nerve was the seat of destructive injury.

Vertigo was a symptom in many cases of intracranial traumatism, and in the absence of probable basal fracture, especially when following profuse external hemorrhage from the ear or in conjunction with manifest evidences of cerebral contusion, should be regarded as a general rather than a focal symptom. If, on the other hand, vertigo is closely associated with an aural hemorrhage or serous discharge indicative of basal fracture, as happened in many cases, and the cerebral

circulation apparently is not greatly disturbed, it would seem that local injury of the auditory nerve should equally be regarded as its efficient cause. Two cases will serve to illustrate this probable relation of vertigo to nerve injury.

CASE LXXVI.—A man fell from a truck upon the back of his head. There was hemorrhage from the right ear which continued for twenty-four hours; headache, deafness, vertigo, and mastoid ecchymosis, together with the impairment of the special senses of taste and smell, which persisted for two weeks. Pulse and temperature were normal from the time of first observation on the tenth day and there were no general symptoms.

CASE LXXVII.—A man while sleeping fell from a third-story window. On immediate admission to the hospital there was profuse serous discharge from the ear and severe vertigo aggravated by rising in bed or opening his eyes. The pulse was normal in force and frequency. On the eighth and ninth days he had epileptiform convulsions; and on the twentieth he began to have an inflammation of the mastoid region for which he was trephined with negative result. The temperature but once exceeded 99°.

Dysphagia was observed in 17 cases of which 13 were fatal. It was usually an incomplete paralysis, and in fatal cases was permanent. It was both an early and a late symptom, and in many instances was variable from day to day. Articulation as well as deglutition was difficult in 6 cases, and in a seventh it was alone affected. In 4 cases, 3 of meningeal effusion and 1 of pial hemorrhage into the basal fossa, there was no other assignable cause apparent for the dysphagia or aphonia than compression of the nerves which supply the lingual and pharyngeal muscles. In the 5 cases remaining the sole or essential gross lesion was in each a cerebral contusion; and in these it seems necessary to assume a lesion of the cerebral centre or centres of control. This view is strengthened by the fact that in 3 of the fatal, and in all of the recovering cases, there was evident lesion of the left frontal lobe which is adjacent to the controlling centres of these muscles.

The following cases are representative of the two forms of pharyngeal paresis.

CASE LXXVIII.—The patient from the fourth day was delirious in varying degree till her death ten days later. There was difficulty in deglutition at intervals from the seventh day, and just before death dyspnœa and dysphagia were extreme.

Lesions.—Fracture through left occipital fossæ, extensive laceration of inferior surface of left frontal lobe, and all the basal fossæ filled with cortical clot; thin pial hemorrhage over entire left, and posterior half of the right hemisphere.

CASE LXXIX.—Protracted hemorrhage and serous discharge from the ear; bronchitis which developed on the fifth day and began to subside on the seventh. No symptoms referable to intracranial injury were noted till the eleventh day, when there was occipital pain and rising temperature, followed by somnolence, continued rise of temperature to 104°, and rigidity of the cervical muscles. Still later there was active delirium and deafness. From the twenty-fifth to the thirtieth days hearing and articulation were wholly lost, the patient could communicate only by gesture. Dysphagia occurred somewhat suddenly, a little later than the aphonia. Death occurred on the forty-first day, following progressive emaciation, paralysis and anæsthesia of the left lower extremity, and loss of rectal and vesical control.

Lesions.—Fracture through outer portion of right petrous bone; no intracranial hemorrhages or cortical lacerations; thrombus in each lateral sinus from the torcular Herophili into the jugular foramen; patches of lymph upon the vertex; several ounces of turbid serum in the basal fossæ, and a membranous exudation covering the pons and inferior cerebellar surface; large serous effusion in the lateral ventricles.

CASE LXXX.—The patient on admission to the hospital was unconscious, and later rational with slow cerebration. On the second day there was some dysphagia referred to the left side of the pharynx, and a barely perceptible left hemiplegia which was progressive but always slight and variable in degree. On the seventh day there was a very slight facial paralysis with loss of rectal and vesical control. Dysphagia continued till death from asthenia on the twenty-eighth day.

Lesions.—No fracture; no intracranial hemorrhage; no cerebral laceration; large subarachnoid serous effusion in the frontal region; excessive hyperæmia of the cerebrum with minute vessels everywhere filled with coagula.

CASE LXXXI.—The patient's condition until the sixteenth day was characterized by stupor and increasing mental disturbance with moderate temperature. His speech then began to be thick and difficult to understand. Rectal and vesical control was lost, and he had delusions but was otherwise rational. His speech grew more difficult, and on the twenty-fifth day he had dysphagia. He died three days later, his temperature having risen to 109.4°; and was 109.6° forty-five minutes post mortem.

Lesions.—Fracture through right middle fossa; no intracranial hemorrhage; moderate subarachnoid serous effusion; marked left frontal atrophy; entire brain substance, including cerebellum and basal ganglia, hyperæmic and œdematous to an excessive degree.

Reference has been made to cyanosis and pulmonary œdema from compression of the pneumogastric nerve as a disorder of respiration. As a distinctive symptom the two conditions must concur. It is of only occasional occurrence, and is not usually associated with that compression of the respiratory ganglia which has been described, but is even more uniformly fatal. The compressing agent is blood derived from a pial or cortical hemorrhage into the posterior basal fossæ. The pressure exerted by an epidural extravasation is insufficient to inhibit function by reason of the intervention of the dura mater.

CASE LXXXII.—The patient was found helpless in the street and unable to speak. His limbs were flexed and his muscles spastic. The left pupil was dilated, and neither pupil reacted to light or accommodation. There was slight mastoid ecchymosis. No disturbance of respiration; temperature 98°; pulse 120; respiration 24. On the third day the patient, previously quiet and apathetic, became restless, and soon afterward cyanotic with pulmonary œdema.

Lesions.—Two cranial fissures in inferior occipital fossa: one through groove for lateral sinus into the jugular foramen, the other into the foramen magnum; no epidural or pial hemorrhage; extensive laceration of inner border of cerebellar lobe; cortical hemorrhage in inferior occipital fossa.

Lingual paralysis was noticeable in but two instances; in

one it persisted until the patient was discharged from the hospital, and in the other until his death. The first was unaccompanied by other paralysis, the second by facial paralysis and ptosis. It is probable also that in cases of dysphagia or aphonia the lingual muscles may have been in some degree involved.

It is evident from this summary of cases that in functional loss or derangement of parts to which cranial nerves are distributed these nerves are not necessarily at fault. The only focal symptom which is invariably chargeable to lesion of a cranial nerve is the cyanosis and pulmonary œdema which has been described. Diagnosis may be positive in one other condition. The implication of an optic nerve in a line of fracture through the optic foramen may be determined by ophthalmoscopic examination; with this exception the seat of lesion, whether of the nerve or cerebral centre, can be inferred only from the history of the case and the associated symptoms; and with how great a degree of certainty this can be done may be estimated from a study of the various histories which have been cited.

Cerebral Centres of Control.—A number of instances in which symptoms are occasioned by lesions of definite centres of control have been already noted. They include retardation and stoppage of respiration from compression of the respiratory ganglia, certain cases of paralysis from lesions of the motor area, and certain other cases of loss or impairment of the special senses of sight, smell and taste and loss of power in the muscles of the eye, tongue and pharynx. There remain mental derangement, exclusive of acute mania or delirium, and aphasia.

Mental Derangement.—The fatal cases in this series which were marked by distinctive symptoms of intellectual and emotional disturbances were cited in two monographs relating to localization of the mental faculties in the left prefrontal lobe.[19]

[19] Phelps, American Journal of Medical Sciences, April–May, 1902; March, 1906.

They were supplemented by a certain number of cases terminating in recovery, and the subject was fully discussed and various considerations presented which substantiated a belief in the actuality of such a localization. It will be unnecessary therefore to do more than to reiterate the statement of conclusions then reached, and to reproduce from those publications two well marked antithetical cases; one of lesions of the left frontal, and one of the right frontal lobe. Those conclusions were:

1. Mental decadence always attends conjoint lesion of both prefrontal regions.

2. Mental decadence always attends lesion confined to the left prefrontal region.

3. Mental decadence never attends lesion confined to the right prefrontal region.

These postulates were based primarily upon a study of the cases proper to this series, and their correctness was confirmed by the records of other reported cases of traumatisms, abscesses, tumors and congenital defects, as well as by results of experimentation. The histories of all the original cases, 29 in number, were detailed, and while some were conclusive, none were contradictory and the greater number were convincing, as were those reported by other writers by whom these facts had not been recognized. If by chance exceptional cases should be encountered, which are inconsistent with the belief in the existence of such a localizing region, they need not be regarded as necessarily invalidating the results of positive clinical and post-mortem observation. It should be borne in mind that functional anomalies are often explicable by anomalies of cerebral structure; that, *e.g.*, the lesion has more than once been found to be upon the same side with a hemiplegia, and that the removal of the entire left temporal lobe was followed only by temporary right hemiplegia and doubtful hemianopsia; and that the observation of a single case led Trousseau to deny the truth of Broca's discovery. If the same nature and degree of proof which is deemed sufficient to establish centres for the localization of other cerebral functions may

be accepted for the mental faculties, their centre of control has been established.

This localization, as it was stated, is simply one of topography and has no reference to the nature of the control exercised, whether one of co-ordination or of inhibition, or to the psychological theories of various authors. The fact that mentation has an anatomical substratum having been accepted as an almost axiomatic truth, it only remained to determine whether this physical basis was more or less precisely delimited or was generally diffused in the cerebrum.

CASE LXXXIII (Abstracted from Case LX in Monograph of 1902).—The patient was primarily unconscious and in shock with widely dilated and irresponsive pupils; compound comminuted depressed fracture extending through the inferior portion of left parietal bone from coronal suture to mastoid process; much brain matter extruded and lost. The disintegrated brain area involved at least the posterior half of left frontal and upper part of left temporal lobe; just how much farther this area extended anteriorly and inferiorly could not be accurately determined without unjustifiable exploration. On regaining consciousness the patient muttered and laughed for fifteen minutes; on the second day he was irritable and irrational but not delirious; on the third day his speech was mere gibberish and he laughed and cried at intervals; on the seventh day he could understand English but could not speak it; in the second week he was actively delirious; in the third week he could speak a few words of English, was very emotional, and wore a peculiar fatuous smile. Before his injury he usually spoke in the Norwegian language; when he regained speech it was English only; his Norwegian vocabulary was afterward limited to a few words. At the end of three months he said if he were to return to work he would be unable to comprehend orders. He was still emotional and cried often, though his wife stated she had never heard him cry before he was injured; he had various manifestations of aphasia; his power of attention began to improve though his mental faculties were generally weakened. His symptoms, with the exception of long-continued dilatation and inaction of the pupils, were at all times confined to disorders of the mind and speech.

CASE LXXXIV (Case VII of Monograph of 1906).—The patient was made primarily unconscious but walked several miles to a hospital. On admission he was very weak and somewhat apathetic but his mental condition was normal. On the following day some osseous fragments were removed from the right orbit and a cerebral cavity as large as an egg disclosed which had been formed by destruction of the anterior portion of the first, second, and third right orbital convolutions. There were no subsequent mental symptoms, and none of importance physically except some rise in temperature.

The following is illustrative of that class of cases with recovery in which left frontal lesion has been assumed to exist.

CASE LXXXV.—The patient, who had no history of alcoholism, was primarily unconscious. On admission to the hospital he was still unconscious with normal pulse and temperature. He had a contusion of the right side of the head and neck, but no hemorrhage from the ear. He had also left facial paralysis and loss of vesical control; temperature on the third day rose to 102°. On the fourth day he could be aroused, and seemed vaguely conscious of what was said to him; he was emotional, his left leg and arm movements were unsteady, and reflexes on the left side were slightly exaggerated. On the eighth day he was able to sit up and talk rationally for two or three minutes at a time, but then became erratic. In the fourth week his facial paralysis had disappeared, the use of the left arm was normal, but the left lower extremity was still paretic. He was coherent but irrational and answered questions with a peculiar grin. He said variously that when improved he was going to the morgue, that he was going to some village (named), in Germany; that he was accompanied by seven men or by some other number which was variable; that he was in Bellevue learning to be an inspector of farms; and usually believed that he was in Germany.

At the time of his discharge from the hospital in the second month his mental condition was apparently normal.

There is often a single fixed delusion which is persistent, though perhaps accompanied by others which are transitory

and variable, as in the case just cited; or as in Case LII of the collection of cases to which reference has heretofore been made,[20] in which a longshoreman who had fallen from a ship's deck was quite certain up to the time of his death, twenty-four days later, that he had fallen from a mulberry tree in Fordham; and described the occurrence with great and unvarying circumstantiality of detail. This case, which was one of laceration of both frontal lobes, escaped inclusion in the series of frontal lesions which it would have increased to thirty. The delusion as in these cases is perhaps most often one of locality. It may, however, be one of an entirely different nature as in Case CCLXXVIII of the same collection.[21] This patient suffered acute anguish for some weeks on account of the fancied death of his wife, and for many weeks afterward on account of the death of a child. He had never had either wife or child, as the other man had probably never seen either Fordham or a mulberry tree. The persistent delusion is sometimes unaccompanied by others, and may be of singular character; as in case of the hobo who had probably never worked in his life, and was honestly anxious to leave the hospital that he might get back to his work; or the man who confounded the sexes and thought every man he saw was a woman, and every woman a man.

The mental derangements which result from cerebral traumatism do not exactly correspond to any form of mental disease included in the nomenclature of the alienists, but the term traumatic dementia which has been sometimes used sufficiently serves the purpose.

Aphasia.—There were 30 cases in which aphasia was a symptom, 24 of which terminated in recovery.

It is perhaps a matter of interest rather than of importance that in 28 instances the subjects were males; and it is probable even that one of the two female subjects became aphasic from an apoplectic seizure rather than from the traumatism, since

---

[20] Traumatic Injuries of the Brain.

[21] *Lib. cit.*

a week had elapsed from the time of injury without intervening symptoms; and the later loss of speech was attended by the usual symptoms of that form of cerebral hemorrhage. The accident or influence of sex parallels the sex condition in traumatic convulsions, in which 101 out of 110 patients were males; but while the greater frequency of convulsions in man may be explicable upon the supposition of a sexual difference in reaction to a general irritation, it is inconceivable that sex should affect the result of a structural injury of a cerebral centre. If males are more liable than females to suffer traumatic aphasia it can only be ascribed to a greater general exposure to intracranial injuries.

There were certain attendant symptomatic conditions so often present as to be in a measure characteristic. These were in frequency and in detail:

Muscular disorders	27
Paralyses	18
Convulsions	4
Muscular rigidity	5
	27
Mental disorders distinctive of left prefrontal lesion	13
Loss of impairment of special senses	4

Six of the paralyses were hemiplegias, and the remainder were of the face, pharynx, or upper extremity.

The frequency of these concomitant symptoms is quite comprehensible in view of the propinquity of corresponding centres of control to those of speech. The area in which all these centres are localized, the frontal and temporal convolutions, in the island of Reil, and the margin of the Sylvian and Rolandic fissures, is so limited that the usual comprehension of two or more of them in a common lesion seems almost inevitable. In a majority of cases two or more centres were involved, not only associating different forms of aphasia with each other, but with one or more paralyses or with functional loss or impairment of special senses. The right hemiplegia

which has been accounted a specially characteristic complication of aphasia was noted in only 6 cases, and paralysis limited to the right upper extremity in 3 others. There was in one instance the exceptional occurrence of paralysis of a corresponding extremity. The history of this case is appended. The paralyses were usually incomplete and often transient.

The general symptoms were as varied as in cases of cerebral injury in which the disturbance of speech was absent; and in some instances no general symptoms were observed. No complicating symptoms, aside from those which were mentioned as allied through community of lesion, was characteristic. As with other intracranial lesions that of the speech centres occurred with and without cranial fracture. There were 18 cases with fractured base, 4 with fractured vertex, and 8 in which no fracture had been sustained. The several forms of aphasia as they may co-exist in a given case cannot always be recognized on account of the concurrence of stupor or delirium, or as it sometimes happens because the patient speaks only in some unusual dialect for which no intelligent interpreter is obtainable. Their classification in the present series of cases so far as it was possible to be determined was:

Motor Aphasia	7
Sensory Aphasia	4
Sensory Motor	14

Motor aphasia was noted in 5 other cases in which the pressure or absence of sensory disturbance could not be ascertained on account of a condition of delirium or dementia or by reason of an unintelligible dialect. The varied forms of aphasia, motor, auditory and visual including paraphasia and agraphia, were all represented in this series. Their manifestations, however, were not different from those which have been described in other reported cases.

The aphasic condition was undoubtedly primary in 11 cases, and secondary in 5; positive knowledge of the time of its occurrence in the remaining 14 was wanting on account of the persistence of early unconsciousness, delirium, or stupor, or

the lack of history prior to a late admission to the hospital. When known to be secondary it was first apparent from the second to the twelfth day; and in the doubtful cases it was first discovered within the same limits.

Aphasia persisted till final unconsciousness in all the fatal cases, and till the patient's discharge from the hospital, a period varying from eleven days to five months, in 9 of the 24 cases which terminated in recovery. In the remaining 15 cases, nearly two-thirds of those in which the patient survived, all aphasic symptoms, except at times some slight hesitation in speech, disappeared in from twelve days to three months. In five of those in which a notable degree of aphasia persisted at the time of last observation, improvement was still progressive and gave promise of complete restoration of motor and sensory function. The statistical prognosis therefore in traumatic cases may be considered good—much better than when the speech defects result from embolism or thrombosis.

Four of the 6 fatal cases afforded opportunity for post-mortem examination. The histories of 3 of these were detailed in the Monographs upon frontal localization, as was that of a case in which several forms of aphasia resulted from the growth of a tumor in the left frontal lobe. The relations of aphasic conditions to lesions in these cases is shown in the abstracts of histories which follow.

Case LXXXVI.—Primary delirium with paraphasia at end of two hours, both of which continued till final coma at the end of thirty-four hours. This patient could utter single words correctly, or a number of words in succession, each correct in itself but strung together without connection: as, "water—father—who," or "Jesus—now—who." He also connected fragments of words as: "en—is—other," meaning when is mother; or "ter—J," for water—Jesus. The clue was found in the words he constantly used.

Lesions.—Fracture and epidural hemorrhage confined to left occipital region and corresponding fossa; thrombus in left lateral and superior petrosal sinuses; moderate subarachnoid serous effusion; laceration involving the exact width and whole thickness of

cortex of first and second left temporal convolutions, 1½ inches long, embracing the second and part of the third fifths of the first, and the middle portion of the second convolution, estimated from the anterior extremity; small and deep laceration in the centre of inferior surface of same lobe; small and shallow laceration at tip of the lobe, implicating all three convolutions; similar laceration at tip of right temporal lobe involving second and third convolutions; extensive laceration of inferior surface of left frontal lobe, extending from its anterior border to the optic chiasm and from the median line outward through first, second, and third orbital convolutions, and into the subcortex; cortical hemorrhage in middle portion of anterior fossæ, extending over sella turcica into middle fossæ; general cerebral contusion indicated by hyperæmia and thrombi in the minute vessels.

Case LXXXVII.—Paraphasia on the second day, followed on the third by aphemia which was permanent; later right hemiplegia, left facial paralysis, and paroxysms of facial spasm which became general; no sensory speech defects. Death on the sixth day.

Lesions.—Fracture through right middle fossa; general meningeal and cerebral hyperæmia, excessive on the left side; thrombosis of minute cerebral vessels throughout cortex on the left side; subarachnoid hæmatoma derived from rupture of left Sylvian artery, and extending along Sylvian to median fissure, 7 cm. wide in its broadest part; subjacent cortex eroded; neuroglia generally increased.

Case LXXXVIII.—Primary unconsciousness which continued till second day; muscles spastic; pupils unsymmetrical; lack of rectal and vesical control; single convulsion; aphemia discovered on the third day; visual aphasia and agraphia still later. Death on the eighth day.

Lesions.—Fracture of right parietal bone from anterior inferior angle to parietal eminence; epidural hemorrhage along line of fracture, with flattening and compression of the underlying convolutions; small hemorrhages into pia mater and subjacent cortex of the right frontal lobe, largest upon its inferior surface; extensive laceration of anterior two-thirds of left temporal, and of inferior surface of left frontal lobe; softening and infiltration with blood of inferior portion of first, second, and third left frontal convolutions; entire destruction of left island of Reil; areas of

softening extending from Sylvian fissure to posterior commissure; cortical hemorrhage covering whole frontal lobe; general cerebral hyperæmia; hemorrhages of considerable size in all parts of the pons.

CASE LXXXIX.—Primary unconsciousness and later mental derangements prevented examination as to speech defects until late in the third week; patient then paraphasic, and from that time was irrational or actively delirious and further examination was again precluded. There was no motor aphasia.

Lesions.—Pachymeningitis interna and externa; turbid serous effusion in basal fossæ; general cerebral sclerosis; atrophy of both frontal lobes, more marked in the left; abscess involving left temporal, and anterior part of left occipital lobe.

CASE XC.—*Tumor.*—Motor, auditory, and visual aphasia; amusia and agraphia; all well marked and permanent. Death in the fourth month.

Lesions.—Tumor occupying anterior two-thirds of left frontal lobe; anterior border of Broca's convolution compressed, atrophied and forced backward, with substitution of tumor tissue for degenerated neural elements; inferior border of second convolution slightly involved. The cyst interrupted or displaced the efferent fibres of Broca's convolution; and destroyed all association fibres which entered or left the third, and many of those of the first and second convolutions. The general tissue of the brain presented a normal appearance except in those parts invaded or compressed by the neoplasm.

A point of interest in this case was a complete loss of a language acquired and constantly used in later years, and a reversion to one of childhood long since forgotten. He wrote and spoke in English as well as in French and German before his illness. After his coming to the hospital he spoke only in the Russian tongue which he had not spoken before in fourteen years, and was much annoyed that his attempts to speak in English or German failed. In still another case previously cited the patient had usually spoken in Norwegian, but when he regained the power of speech it was only English. He a little later recalled a few Norwegian words, but their number was not increased. His English vocabulary was gradually extended. Both patients could understand the language which they could not speak.

These observations made in cases with necropsy are supplemented by eight others in which the cranium was opened in operative procedure. Five were cases of compound fracture and three of explorative operation; all in the left fronto-parietal region. Cerebral laceration in the speech area existed in all the cases of compound fracture, but was discovered in none of those subjected to explorations. In one of the exploratory cases a minute pial clot with normal cerebral surface was disclosed; in a second, in which a large area was exposed, the dura mater was tense but on incision no lesion was apparent; and in the third there was temporary lack of cerebral pulsation, but again there was no evident gross lesion. In all the operative cases save one the patient survived.

There were cerebral lacerations corresponding to pre-existing aphasic conditions in all the cases with necropsy, and in three of those with operation for the relief of compound fracture. There were further lacerations in 5 of the 8 cases to which there had been no corresponding form of aphasia; but in each instance the discrepancy was more or less explicable by the persistence of unconsciousness, delirium, or other mental defect. In the two remaining compound fractures the site of injury was distant from the recognized centres of the speech defects observed; and as already stated no gross lesion was discovered in either of the cases in which aphasia was a symptom and exploratory operation was made.

There is no reason so far as these cases are concerned to question the accuracy of the generally accepted localization of centres of control for speech and allied forms of expression; but in several of the cases cited there is conclusive evidence that no gross lesion is essential to their loss. The case of tumor in the frontal lobe in which every sensory aphasic condition was strongly pronounced and in which lesions were strictly confined to the frontal lobe is a marked instance. It has been assumed that in the known or probable absence of cerebral laceration aphasia may result from the compression exerted by a hemorrhage. This assumption is neither substantiated by facts nor sustained by theoretical considerations.

There are in the present series of cases many in which, with consciousness retained and speech conditions normal, a considerable hemorrhage was found to extend over the speech area and there was no case in which, from cumulative hemorrhage in the same region consciousness was gradually lost before death or relief by operation, in which aphasic symptoms were observed at any time in its progress. There have been cases reported in which motor and perhaps other forms of aphasia have been attributed to small localized hemorrhages, but none in which lesion of the brain tissue has been excluded. In a case previously quoted,[22] a limited superficial hemorrhage was regarded as the cause of a motor aphasia; and though some improvement resulted, the continuance of the aphasic conditions for years afterward indicated a deeper seated lesion unrelieved by operation. The effect of a limited cortical hemorrhage would necessarily be lost in that of the underlying laceration and inevitable adjacent limited contusion.

Compression to be effective must be exerted with firmness and precision. The compressing force in epidural hemorrhage is so diffused and minimized by the fibrous shield of dura mater that even when excessive it is deficient in both essential conditions. It may be said in general that no form of intracranial hemorrhage can reasonably be expected to so compress a very limited cerebral area as to destroy its functional activity; when large the compressing force is too diffuse, and when small too slight to be efficient. Aside from this consideration the loss of consciousness which must always attend any large intracranial hemorrhage whether epidural or subdural, will of itself abrogate speech and all other manifestations of intellectual life.

It seems to be well established, therefore, that in aphasia, as with many other focal symptoms, there are many cases in which the essential lesion must be sought in some structural change invisible upon ordinary inspection, or at the most indicated only by some circulatory disturbance. The recovery of the patient in so large a proportion of cases, and the frequent

[22] *Lib. cit.*

strict limitation of the defect to a single one of its phases as well as its often transitory nature must serve to strengthen the conclusion that it is independent of the grosser forms of injury.

The comparatively short duration of aphasic conditions in some instances is illustrated in the two cases which follow. In two others, one of motor aphasia, and the other perhaps involving some sensory defect, it did not extend beyond the fourth day.

CASE XCI.—A man 38 years of age was admitted to the hospital in an intoxicated condition, with no history and with profuse hemorrhage from the left ear. On the second day he was mentally confused and suffered much from vertigo and general headache. He was unable to state the place of his employment, and could only suggest his occupation of waiter by indicating in dumb show the use of a corkscrew. There were no pupillary symptoms at any time, no loss of rectal or vesical control, and no muscular disorders. On the seventh day his condition was in all respects normal. His temperature ranged 99.2°, 100°, 98°.

CASE XCII.—A man who had been struck upon the head with a bottle was primarily unconscious; but on arrival of the ambulance had recovered consciousness. He could not give his name in speech but could write it. Motor aphasia with no sensory defect continued for eight days without general symptoms. He had sustained a fracture in the left temporoparietal region for which he was trephined and the osseous fragments were elevated and some small pieces removed. There was no evident intracranial lesion beyond a slight epidural hemorrhage.

There was no instance of the exceptional occurrence of left hemiplegia, but there was an instance of paralysis of the left face and left upper extremity which belongs to the same category and is susceptible of the same explanation without the necessity of supposing a cerebral anomaly—for the patient was not left-handed. There were probably bilateral lesions in this case, as has been often noted in other cases in which post-mortem examination was made.

CASE XCIII.—The patient, a man 46 years of age, was knocked down in the street and was at once admitted to the hos-

pital with paralysis of the left face and left upper extremity, slightly dilated and immovable pupils, and normal reflexes. He was semi-conscious; his temperature was 95°, pulse 60, and respiration 24; and he had no extracranial hemorrhages. On the second day he was incoherent and at times wildly delirious. On the third and fourth days his mental condition improved and motion in the upper extremity was restored. On the sixth day he became rational, could repeat single words when dictated, but could not recall his name. On the day following he could remember one of his names, but could not write it, and could not recall with certainty the names of familiar objects, and could not always repeat words or the names of things on dictation. Facial paralysis disappeared, but ptosis and diplopia persisted. On the tenth day he could repeat his full name and he could answer most questions with some hesitation.

The analysis of so large a number of cases, observed under similar conditions, could hardly fail to disclose some new facts in pathology and symptomatology, and to accentuate some others which were perhaps already known. The independence of the symptoms of cranial fracture and of intracranial lesions, the intervention of the sympathetic system in the production of symptoms of intracranial injury, and the relations of temperature to consciousness and in general to prognosis and diagnosis, are some of the more important of its disclosures; but the one fact of paramount importance which it establishes is that the essential lesion is the same in every class of intracranial injuries, and that it is a structural change in the cellular elements; that lacerations and hemorrhages are accidental, and not essential; that whatever influence these lesions may have in determining the more intimate pathological condition they are but a part of a general contusion which may equally occur in their absence. This is the inevitable conclusion which has resulted from the examination of every symptom in detail, focal as well as general, since in each instance many cases were found with no other gross lesion than a more or less well pronounced circulatory derangement or even with no evident change at all.

INJURIES OF THE KIDNEY.*

BY ALEXANDER B. JOHNSON, M.D.,

OF NEW YORK,

Surgeon to the New York Hospital.

On account of the position of the kidney in the abdomen, protected as it is by the spinal column, by thick layers of muscles, and by the thoracic wall, great force is necessary to injure it from behind; and its deep position protects it also from all but extreme degrees of violence from in front. Accordingly, injuries of the kidney are comparatively rare. In battle, injuries of the kidney, as the result of gunshot wounds, are probably fairly common, but in most of the cases associated grave injuries of the spine and of the abdominal viscera so commonly co-exist that the wounds rarely come under the care of the military surgeon. In civil life, also, gunshot and stab wounds of the kidney are relatively rare injuries. Contusions and ruptures of the kidney, as the result of blunt violence without external wound, are much more common; only very rarely are injuries of the kidney by blunt violence associated with an extensive contused and lacerated wound. As might be expected, all the forms of kidney injury are far more frequent in males than in females, and they are more frequent during the second and third decades of life than earlier or later; although in large cities, like New York, where run-over accidents are so common, a considerable proportion of the ruptures of the kidney occur in children. A large proportion of all subcutaneous injuries of the kidney are associated with grave traumatisms to the other abdominal viscera, to the spine, etc. Küster collected the statistics of 306 cases of injury to the kidney without external wound. He found that the right kidney was injured more often than the left, and that 93.98 per cent. of the cases were males, 6.02 per cent. females. A

* Read before the New York Surgical Society, May 12, 1909.

nearly similar proportion existed among children under fifteen years of age. Of these, there were 41 cases, and 33, or 80.48 per cent., were boys; only 8 were girls. Küster explained the infrequency of kidney injuries in the female not only by their less active mode of life and less frequent exposure to external violence, but also on account of the fact that the broader pelvis and more prominent crests of the ilia in women served to protect the kidney from direct violence. Further, that women usually have a thicker layer of fat; that their corsets also probably serve to protect them to some extent. The rarity of injuries of the kidney may be illustrated by the following facts: From January 1, 1890, to October 1, 1898, only 7 cases of injury to the kidney, requiring operation, entered the Roosevelt Hospital in the city of New York, a hospital where the accident service is very large. A number of cases of injury of the kidney other than these were treated in the hospital by conservative measures, the kidney lesion not being severe enough to merit operation. Of the cases operated upon, all were males, and all but 2 were young adults; the ages ranged between twenty-eight and ten years. In 5 of the cases the injury of the kidney was caused by the patient falling some distance and striking against some hard object, which injured the loin or the lateral wall of the belly. One case was crushed between two cable cars. In the seventh case the patient, who was riding a bicycle, collided with the shaft of a wagon, which penetrated his right pleura, diaphragm, peritoneum, liver, and caused a contused and lacerated wound of the right kidney (Dr. Robert Abbe's case). Thus 6 of these cases were subcutaneous injuries. Since 1898 only 6 cases of injury of the kidney requiring operation have come under my personal observation. One was a rupture of the liver, the kidney, and the lung. The patient, a child of nine years, survived. One was a rupture of both kidneys, ending fatally. One was a lacerated wound of the kidney, produced by a fractured twelfth rib; the broken end of the rib penetrated the substance of the kidney. A fourth was a gunshot wound of the kidney, associated with wounds of the intestine, diaphragm, and lung. The

patient died. One was a stab wound of the kidney, requiring suture. One was a subcutaneous laceration of the kidney, requiring nephrectomy on account of persistent bleeding. I recall an unusual case seen by me when I was house surgeon in Bellevue Hospital in the service of Dr. Frank Hartley, a stab wound in the right loin, which opened the peritoneal cavity, wounded the liver, and made a deep cut into the substance of the right kidney. The knife entered between the ninth and tenth ribs, midway between the mammary and axillary lines, and transversed the right kidney from the outer to the inner border. A small urinary fistula persisted for six months.

In 1896 Keen tabulated 155 cases of injury of the kidney. Of these, 19 were gunshot wounds, 8 were penetrating wounds of other descriptions, 118 were subcutaneous ruptures, 6 traumatic hydronephrosis, 2 partial nephrectomy for rupture, 2 ruptured ureter (pelvis). From these statistics one sees that subcutaneous ruptures of the kidney are far more common than open wounds. The injuries to the kidney substance vary much in severity, from slight contusions, attended by only a small amount of hæmaturia, to severe crushing injuries, in which the kidney may be pulpified or torn completely in two. The causes of rupture of the kidney are falls from a height in which the individual strikes some more or less prominent hard object, thus injuring the kidney by direct violence; or sudden and very forcible flexion of the trunk upon itself as the body strikes the ground. Other causes are blows upon the loin or the front of the abdomen, and sometimes violent muscular effort. The cases which I have seen of rupture of the kidney have been chiefly from falls or run-over accidents. Several cases of rupture of kidney from muscular violence have been observed. Thus, Clement Lucas reported the case of an elderly man who was walking behind a wagon loaded with heavy sacks; one of these fell to the ground, and he endeavored to catch it by grasping it suddenly with both hands. He felt a severe pain in the left side of the abdomen and back, and passed blood with his urine. A second case was reported by Campbell. A young girl of fourteen bent her body forcibly

to the left side while jumping over a hedge. She immediately experienced severe pain in the region of the kidney, and passed blood with her urine.

While the mechanism of ruptures of the kidneys by direct violence, the result of crushing injuries or blows upon the front of the abdomen or the loin, is sufficiently clear, other cases of ruptures of the kidney occur in which the violence is exerted against some distant part of the body, as when the patient falls from a height, and suddenly flexes the trunk violently, either anteriorly or to one side. Ruptures of the kidney under these conditions have been explained by the theory of hydraulic pressure, sometimes by the pressure of the ribs. Unquestionably when the lower ribs are broken the kidney may be wounded, as in the case of my own cited above. It is comprehensible that as the result of a sudden violent commotion of the body the kidney might be projected by its own inertia against the transverse processes of the vertebræ, and thus injured. The explanation of ruptures of the kidney by hydraulic pressure was made satisfactorily by Küster, who tried a number of experiments upon kidneys removed from the body and produced ruptures of various kinds, indicating that a sudden increase of hydraulic pressure was the cause of the rupture. He also found that even in the bodies of old persons after the intestine had been removed sudden violent pressure upon the lower ribs of the left side caused the ribs to bend inward and to come into contact with the kidney. In ruptures of the kidney from hydraulic pressure the lines of rupture usually radiate from the hilum toward the twelfth rib. In cases of rupture of the kidney from muscular violence, it is assumed that the muscles acting upon the lower ribs cause them to move inward, and thus compress the kidney against the spinal column.

The character of the injury to the kidney varies, as stated, in a number of ways: In the cases which I have personally seen, in two a simple transverse fissure of the kidney existed, running from the hilum to the convex border. In one the kidney was completely torn in two at about its middle. In one a contusion

of the kidney existed without rupture of the capsule, but with the laceration of an artery in the kidney substance of considerable size, so that an arterial hæmatoma or traumatic aneurism was produced, which bled the patient nearly to death in the course of about four weeks. In another case, operated upon in the Roosevelt Hospital by Dr. Frank Hartley, there was rupture of the kidney capsule, the kidney itself was extensively contused, and a very large hemorrhage had occurred into its interior, so that the organ was greatly increased in size. Much of the disorganization of the kidney substance had probably been caused by the pressure of extravasated blood. In another case, a child of ten years had a severe injury from a fall upon the right loin and suffered from marked hæmaturia. Exposure of the kidney for septic symptoms two weeks after the injury discovered a necrotic area in the substance of the kidney, rounded in shape, an inch in diameter, and about half an inch deep. In another case, where a man was crushed between two cable cars and developed some weeks later septic symptoms, a large tumor formed in the right loin; the kidney was found completely disintegrated at the time of the operation.

SUBCUTANEOUS INJURIES OF THE KIDNEY.

The various grades of subcutaneous injury to the kidney were classified by Schede into five groups:

1. *Injury of the Fatty Capsule of the Kidney and of the Fibrous Capsule without Injury of the Kidney Substance.*—In these cases there is usually a moderate effusion of blood between the kidney and its fatty capsule; the latter is more or less extensively infiltrated with blood, and may subsequently become thickened and indurated from the formation of new connective tissue. Occasionally the hæmatoma results in the formation of a cyst.

2. *Contusion of the Kidney with Hemorrhage.*—Contusion of the kidney substance with hemorrhage occurs, sometimes without gross lesion, sometimes with the formation of solitary or multiple fissures in the kidney, which may be trans-

verse or radiating, and are seldom parallel to the long axis of the organ. The ruptures do not extend into the renal pelvis. Such injuries of the kidney, although they may be accompanied by marked symptoms and hæmaturia, which may be profuse, rarely result fatally unless they become infected, or unless a considerable blood-vessel is torn with the formation of a traumatic aneurism.

3. *Fissures, Single or Multiple, in the Kidney Substance, for the Most Part Radiating from the Hilum, but Extending into the Renal Pelvis.*—In some of these, as in one of my own cases, the kidney may be completely torn in two. These cases are attended by profuse hemorrhage into the surrounding structures, into the fatty capsule, into the retroperitoneal tissues, or if the peritoneum in front of the kidney is also ruptured, into the abdominal cavity. The tendency of such hemorrhages is to spread downward into the mesentery of the small intestine, along the course of the spermatic vessels to the groin, into the scrotum, into the labia majora of the female, into the pelvis, and to appear superficially in the skin of the abdominal wall. These cases are very serious. The accompanying extravasation of the urine forms a dangerous complication; a considerable tumor is usually present in the loin after a few days. Hæmaturia may be absent, since the ureter is often plugged by a clot of blood. As a rule, unless operated upon, septic symptoms develop as the result of infection of the mixture of blood and urine, with the production of a large abscess or of a widespread necrotic inflammation of the retroperitoneal tissues. Late secondary hemorrhages may occur as the result of the necrotic process, and such may be fatal.

4. *Complete Pulpification of the Kidney.*—In these cases the kidney is extensively lacerated and torn, and considerable pieces of kidney tissue may be completely separated from the rest of the organ. The result is not dissimilar to class 3. Unless operated upon these patients die of hemorrhage or of septicæmia.

5. *Injuries of the Kidney, accompanied by Rupture of the*

Renal Vessels, Rupture of the Ureter, or Tearing Away the Vessels and the Renal Pelvis from the Kidney Itself.—In these cases, unless operated upon at once, death ensues from hemorrhage or from necrotic and putrid inflammation and septicæmia.

A sixth class might be added in which, in addition to the injury of the kidney, extensive multiple injuries of the other abdominal viscera or of the lung occur, and while always grave injuries, some of them are saved by prompt operation.

Symptoms, Course, and Diagnosis of Subcutaneous Injuries of the Kidney.—Since most cases of rupture of the kidney occur as the result of extreme degrees of external violence, the symptoms of more or less pronounced shock are usually present immediately after the injury, and are due, as in other cases of severe injury to the belly, to the violent mechanical disturbance of the sympathetic and abdominal plexuses of nerves rather than to any injury of the kidney itself. In other cases the symptoms of shock, even after very severe injuries of the kidney, may be entirely absent; the individual may continue to walk about, or even to work for several hours, until he begins to feel faint from internal bleeding, or until his attention is attracted to the presence of blood in his urine. Accompanying the shock, when present, nausea and vomiting are commonly observed, together with the other symptoms of shock.

Pain.—Following injuries of the kidney, severe pain is usually present at the time of the accident, although it may at first be slight, and gradually increase in intensity, as the effused blood causes tension and undue pressure upon the nerves of the kidney and its capsule, and upon the sensory nerves after their exit from the spinal column. The pain is referred to the region of the kidney, and often radiates downward along the course of the ureter into the bladder, the external genitals, and the inner surface of the thigh. External signs of injury in the neighborhood of the kidney may be present or absent; such may be abrasions, ecchymoses, the signs of a fractured rib, etc. Extreme tenderness over the injured kidney is pres-

ent in all cases. If blood is poured out in considerable quantity in the vicinity of the kidney, a tumor mass will be formed behind the peritoneum, which may gradually increase in size for hours or days, and may extend well down to the umbilicus to one side of the median line, and be felt as a distinct tumor mass or as a mere sense of diffused resistance on palpation. Such effused blood may appear after a day or more upon the skin of the lower abdomen, in the region of the inguinal canal, in the scrotum, in the fold of the groin. Usually, if the effusion of blood is considerable, the patient will lie with the thigh of that side flexed to relieve the tension of the muscles of the back and of the abdominal wall.

Hæmaturia.—The most characteristic sign of injury to the kidney is the presence of blood in the urine. It is to be borne in mind, however, that in several groups of cases hæmaturia may be slight or absent. If the injury of the kidney involves merely the fatty capsule and the fibrous capsule without crushing or tearing the kidney substance, no blood will appear in the urine. In very severe injuries of the kidney—namely, those in which the ureter is torn across, or in which the ureter is soon plugged by a blood clot—the quantity of blood in the urine may be small, microscopic, or even absent. In the cases where the ureter is plugged by a clot the appearance of blood may be delayed for many hours or may be intermittent. In these cases attacks of renal colic may occur, followed by the evacuation of blood casts of the ureter. If the bleeding proceeds rapidly down the ureter into the bladder, the appearances will vary in different cases. The patient may urinate blood in large quantities mixed with urine. If the bladder was empty at the time of the accident, the organ may fill up with partly coagulated blood. In these cases the patient will suffer intense pain in the region of the bladder, will have a constant desire to urinate. The contractions of the bladder wall may, however, be insufficient to force the clotted blood through the urethra, so that complete retention may occur with the formation of a tumor above the pubes by the distended bladder. In other cases the patient may be able to empty the bladder partly,

and will pass urine mixed with blood. From time to time the orifice of the urethra will be plugged by a clot and the stream of urine interrupted, causing severe pain. In these cases it may be necessary to empty the bladder with an evacuator, or to suck it out with a large hand syringe and a large metal catheter having one or more unusually wide eyes. In many cases the quantity of blood entering the bladder will be small; the urine will simply be colored slightly or deeply, and will appear not bright red, but smoky or a dull brown color, indicating that the blood has been in contact with the urine for some time. It is, of course, important to distinguish whether the blood comes from the bladder or from the kidney. This is sometimes possible. Usually in hemorrhage from the kidney the urine is evenly mixed with blood; in hemorrhage from the bladder, on the other hand, the last portion of urine passed often contains more blood than the first. The diagnosis may also be made by washing out the bladder. The bladder once evacuated and washed clean, if the hemorrhage comes from the kidney, further washings will be clear or but slightly stained with blood. If the hemorrhage comes from the bladder, repeated washings will usually appear blood-stained, since the mechanical distention of the bladder by the fluid introduced will usually be sufficient to keep up or to inaugurate fresh bleeding. The cystoscope will enable one to clear up the diagnosis in doubtful cases. If the hemorrhage comes from the bladder, the fluid medium will usually become opaque almost at once; if from the kidney, gushes of bloody urine, in case the bleeding is still going on, may be seen proceeding from the orifice of one or other of the ureters; or a clot may be seen adhering to the orifice of one ureter. If the bleeding has permanently or temporarily ceased, the cystoscopic field may be so clear as to enable us to eliminate the bladder as the source of blood. The passage of cylindrical blood casts of the ureter *per urethram,* while characteristic of renal hemorrhage, is inconstant. When the quantity of the blood in the urine is very large, it is seldom possible to make a differential diagnosis as to its source from microscopic examination. Injuries of the kidney

are usually followed by a traumatic nephritis, and after a hemorrhage from the kidney has ceased, examination of the urine will often detect hyaline casts, sometimes containing granules, sometimes red blood cells and renal epithelium. Such a traumatic nephritis is associated with an albuminuria, and the quantity of albumin is greater than can be accounted for by the small quantity of blood present. Polyuria is frequently present in these cases. Traumatic nephritis is sometimes associated with œdema of the extremities, and even with generalized œdema. This is, however, a relatively rare occurrence. In the very extensive ruptures of the kidney the symptoms of internal hemorrhage may be present of any possible grade. In the worst cases the symptoms of progressive anæmia may increase from hour to hour, and unless operated upon the patient may bleed to death in a very short time. In such cases the local signs of the formation of a tumor mass in the region of the kidney will be marked. If the peritoneum has been ruptured, in addition to the signs and symptoms of hemorrhage, there will be evidences of an accumulation of blood in the peritoneal cavity. The hemorrhage following contusion of the kidney may be intermittent, notably if a considerable artery is torn without rupture of the kidney capsule. This is well illustrated by the following case observed in the Roosevelt Hospital in 1894:

The patient was a boy, aged sixteen years. A week before coming to the hospital he had fallen, while running, against a wooden beam, which had injured his right loin. He did not suffer from shock, and walked a considerable distance to his home, where he went to bed, and remained during the following week. He had observed that his urine was red after the accident. Upon admission to the hospital his temperature was 99° F., his pulse 100. He was passing a diminished quantity of urine, 14 ounces in twenty-four hours. This was slightly brownish in color, and contained a moderate amount of blood. There was pain in the region of the right kidney, moderate tenderness, and muscular rigidity. He left the hospital at the end of the three days feeling better, and desiring no further treatment. Twelve days later

he returned. On the preceding day he had passed a large amount of blood *per urethram*. There was no tumor in the loin nor noticeable tenderness. At this time his pulse had become rapid, 110. He had a slight amount of fever. His urine contained some blood. Upon the two following days he passed a considerable quantity of blood with the urine. The bleeding continued during the next five days with the symptoms of progressive anæmia. Three weeks after the accident his right kidney was removed. The kidney was slightly enlarged. There was a bulging tumor at the centre of its convex border. Upon incising the kidney a considerable cavity was found in the kidney substance, an inch and a half in diameter. This cavity contained a globular clot of bright blood, inclosing firm clots and masses of fibrin, partly decolorized. In the wall of the cavity the open mouth of an artery of considerable size plugged with a soft and recent thrombus was discovered. The capsule of the kidney was not ruptured.

The course of a case in which the kidney was torn completely in two will serve to illustrate another type.

The patient was a man, aged twenty-two years, who was admitted to the Roosevelt Hospital, February 7, 1898. On the day of admission he had fallen, while walking along a beam, a distance of six feet, and had struck with his left loin on the end of a post. He suffered sudden, sharp pain in the loin, and exhibited symptoms of shock. Upon admission to the hospital, examination showed a large, robust man. He was very pale. His pulse was soft and slow, 72 beats per minute. Temperature normal. There was marked tenderness in the left loin over the kidney and abdominal rigidity in front. There was dulness on percussion in the left loin, extending forward as far as the vertical plane, passing through the anterior superior spine of the ilium. Half a pint of nearly pure blood was removed from the bladder by a catheter. The urine for the next two days was continuously bloody. The third day after the accident the blood had nearly disappeared from the urine. The patient was profoundly anæmic. He developed a septic temperature, 104.5° F., his pulse was 115. There was pain, rigidity, and marked bulging of the abdominal wall in the left hypochondriac region and pos-

teriorly. On this day I removed his kidney through a cut parallel with the border of the ribs. Upon approaching the kidney a large retroperitoneal hæmatoma was opened, containing nearly a quart of fluid blood. At the bottom of this cavity the kidney was found torn transversely completely across into two equal portions. The torn edges and the adjoining kidney substance were extensively pulpified. The kidney was removed. Blood entirely disappeared from the urine after the operation, and thirty-four ounces of urine were passed during the first twenty-four hours. The patient made an uninterrupted recovery.

The following case history illustrates that a serious subcutaneous rupture of the kidney may be attended by trifling symptoms at first. In this case the kidney and the pelvis of the ureter were torn by a fall against a hard object.

The persistent hemorrhage would, no doubt, have caused the patient's death had not the kidney been removed.

A. C., male, aged fifty-nine years, native of France, a cook.

On July 6, 1907, at about 7 A.M., he was lowering a small cart down some stone steps. He stumbled and fell a distance of only two or three steps, striking on his left side against the edge of the lowest step. He experienced a sharp pain in his side, but arose, went about his work, and did not consider himself seriously hurt. He had some pain, like a stitch, in his left side, some difficulty in taking a deep breath, and that was all. Nearly eight hours later he had a strong desire to urinate; he went to the closet; urination was difficult and painful, and he observed that his urine was deeply stained with blood.

He sent for and was brought to the New York Hospital in an ambulance.

On Admission.—Patient is a large, stout, and fat man. Skin and mucous membranes normal in appearance. There is a fracture of the tenth rib on the left side about three inches from its anterior extremity.

Abdomen.—There is tenderness beneath the free border of the ribs in the left hypochondrium, and tenderness in the lumbar region of the same side. Temperature, 98.2° F.; pulse, 76; respirations, 20. The patient urinated liquor of a dark wine-color. The patient entered the service of Dr. F. W. Murray. He was

kept quiet in bed. His urine continued bloody. On the eleventh day of July, four days after admission, his hæmoglobin was 60 per cent.; on the seventh day after admission it was 58 per cent.; on the ninth day after admission it was 52 per cent. On that day the left kidney was exposed by Dr. Murray through a five-inch incision parallel with the twelfth rib. The fatty capsule of the kidney was found infiltrated with blood. The kidney itself appeared swollen in its lower half. The capsule propria was incised and the incision gave exit to blood clots. The hæmatoma was cleaned out and the wound in the capsule drained by a strand of gauze. Suture of the external wound. The patient then fell under my care. From July 16th until July 19th the patient continued to pass bloody urine. He suffered from painful and difficult urination and much vesical tenesmus. On this day I again exposed the kidney through the same incision. A jagged rent was found in the posterior surface of the kidney near its lower pole. The tear extended from a point an inch and a half distant from the hilum inward and opened the pelvis of the ureter for a distance of an inch. The borders of the rent in the kidney substance were friable and appeared to be necrotic. The kidney was removed. The patient made a good and satisfactory convalescence. In addition to the lesions described, the kidney contained several small areas of contused tissue resembling infarcts. These areas were necrotic.

Operative Indications.—Only the more severe subcutaneous injuries of the kidney demand immediate operation, the indications being the rapid development of the general symptoms of hemorrhage—namely, acute progressive anæmia or the formation of a tumor mass surrounding the kidney combined with such symptoms or alarming hemorrhage through the ureters and bladder. A good many of the cases where the kidney substance is contused but the capsule is not ruptured, and where the contusion does not extend into the renal pelvis, are attended by only a moderate amount of hæmaturia, which gradually subsides, and is followed by a return to health. In the cases where a considerable artery is torn, with the formation of an arterial hæmatoma in the kidney, repeated hemorrhages of a severe grade constitute a positive indication for

operation. In those cases where the capsule of the organ is torn and where blood and urine are extravasated into the surrounding tissues in the absence of indications for immediate operation on account of hemorrhage there will develop in the course of days or weeks septic symptoms which are accompanied by characteristic signs: The formation of a boggy, tender tumor in the loin, profound prostration, etc., and in these the operative indications will become quite plain. In the cases attended by severe degrees of shock, or accompanied by injury of other important organs, the operative indications must be diagnosticated upon general principles. The surgeon will seek to differentiate the symptoms of shock and hemorrhage. If the symptoms of shock are gradually recovered from in the course of hours, the surgeon may safely wait, unless the amount of bleeding from the kidney is alarming or unless the symptoms of internal hemorrhage are manifest. Those ruptures of the kidney, accompanied by laceration of the peritoneum and extravasation of blood into the peritoneal cavity, will be attended by the symptoms of peritoneal irritation, and, if not operated upon, by peritonitis. The general signs and symptoms of severe abdominal injury, the history of the accident, the presence of severe abdominal pain, rigidity of the abdominal wall, will furnish indications for immediate operation, as in other injuries of the abdomen.

INCISED AND STAB WOUNDS OF THE KIDNEY.

Incised and stab wounds of the kidney are rare injuries as compared with subcutaneous lacerations. The recorded cases in modern publications appear to number less than one hundred. In the American Civil War no case of incised or punctured wound was recorded (Otis). The wounds have been produced by cuts and thrusts with knives, daggers, bayonets, rapiers, scythes, scissors, rarely by impalement on sharp stakes; in one case (Murphy) a man fell upon the handle of a hayfork, which entered the rectum, penetrated the colon, and crushed the upper pole of the left kidney. In Abbe's case the pole of a wagon entered the thorax, wounding the

pleura, liver, and kidney. The wounds have varied in size from narrow punctures to incisions wide enough to permit the prolapse of kidney. Wounds made in front have usually been complicated by injury of other abdominal viscera. Wounds made from behind usually involve the pleura, sometimes the liver.

Signs, Symptoms, and Diagnosis of Incised and Stab Wounds of the Kidney.—From the size, situation, and depth of a wound, injury of the kidney may be visible on inspection or palpation. In other cases the injury may be inferred more or less certainly from concomitant signs and symptoms, or from the character and length of the instrument which produced it, the degree of violence, and the direction of its application.

The free escape of urine from the wound indicates injury of the kidney, involving the pelvis or a wound of the ureter; hæmaturia will usually co-exist. In wounds of the cortical substance merely, both of these signs will usually be absent, or a small amount of transient hæmaturia alone may occur. Urine escaping from the external wound, either alone or mixed with blood, may be recognized by the urinous or ammoniacal odor soon developed in the saturated dressings. If the size, situation, and shape of the wound in the abdominal wall be unfavorable for its escape, the urine will be extravasated into the perirenal tissues or into the peritoneal cavity, and a septic inflammation or a peritonitis will follow, as the case may be, giving rise to characteristic symptoms and signs—*i.e.*, localized pain and tenderness, a boggy swelling in the loin, fever, prostration, etc., or evidences of peritoneal irritation if the extravasation has taken place into the peritoneal sac.

Hæmaturia.—As stated, when the renal pelvis is opened, the appearance of blood in the urine may be almost immediate, and this sign, together with the situation of the wound, is almost certain proof of a wound of the kidney; a wound of the ureter or its pelvis is the sole alternative. Hæmaturia may be absent if the cortex only is wounded, or if the ureter or pelvis is completely divided, or if the ureter is plugged by a

clot, or if a large renal vessel be divided, so that much blood escapes into the peritoneum, into the perirenal tissues, or externally. In some cases blood will accumulate in the bladder, giving rise to vesical tenesmus and frequency, sometimes to retention, as described under Subcutaneous Injuries of the Kidney. Hæmaturia may be delayed for hours, even for days, and may be small in amount, or so severe as to cause death from loss or shock.

The symptoms of shock and the general symptoms of hemorrhage may be present or absent, and possess no distinctive diagnostic importance.

Pain.—Incised wounds of the kidney are not necessarily very painful. The external wound causes pain similar to that of any wound, but the wound of the kidney itself is not accompanied by severe pain unless the tension of the capsule of the organ is increased by blood extravasated beneath it, or unless the pelvis or ureter is plugged by a clot; there will then occur severe pain of a spasmodic character, a typical renal colic, often associated with nausea and vomiting. The pain radiates downward along the ureter into the groin and testis; the latter is retracted. The development of wound infection, of urinary infiltration, or of peritonitis will be accompanied by pain of a character described elsewhere.

To sum up the early diagnostic features of wounds of the kidney I quote from Henry Morris:

(1) That a wound of the renal region followed by the escape of urine through the wound is conclusive of injury of the kidney; (2) that such a wound quickly followed by the discharge *per urethram* of urine heavily mixed with blood is almost conclusive, if not quite so; (3) that such a wound followed by retention of urine, or lumbar or abdominal pain and dysuria, even without hæmaturia, is highly suggestive of a superficial wound and blockage of the ureter; (4) that hæmaturia followed by traumatic peritonitis is strong evidence of an injured kidney.

The following case of stab wound of the kidney was recently treated by me in the New York Hospital:

William C., aged thirty-nine, native of the United States. Foreman of a gang of workmen employed in the construction of a building close by the hospital. At 3 P.M. on September 4, 1906, he got into an altercation with an Italian peddler who was obstructing the sidewalk; as the foreman turned to walk away the peddler stabbed him in the back with a knife having a blade four inches long, sharpened on both edges and three-quarters of an inch wide. The wounded man felt weak and sick; he walked into the hospital, two hundred feet away. He had no pain. Upon admission, examination showed him to be a large, muscular, well-nourished man. He looked pale, his pulse was rather rapid; sole complaint, a feeling of weakness. Upon inspecting the seat of injury, there was a linear wound—three-fourths of an inch long running obliquely downward and forward—situated four inches from the middle line of the back upon the right side, between the eleventh and twelfth ribs. The wound scarcely bled. There were no signs indicating injury of the pleura or lung. After being in the hospital half an hour he urinated three ounces of bright blood.

A diagnosis was made of stab wound of the right kidney. The patient was kept under observation until the following morning, when the continued presence of large quantities of blood in the urine caused me to expose the kidney through an incision below and parallel to the last rib. A portion of this rib was removed to permit easier access to the kidney. There was a hæmatoma of moderate size in the perirenal fat. The kidney was freed and delivered into the external wound. A horizontal linear wound three-quarters of an inch long was then seen on the posterior surface of the organ near the outer border; this wound bled freely as the result of the manipulations. A blunt instrument passed freely through the kidney into the ureteric pelvis. The wound in the kidney was sutured and the bleeding stopped by a single mattress stitch of catgut. The operation wound was then closed in layers, except for the posterior angle, where a gauze wick was introduced down to the kidney. The stab wound in the external soft parts was let alone. After the operation the hæmaturia was at once reduced to a minimum and soon ceased. Primary union was obtained in the sutured portion of the wound and no apparent leakage of urine took place. The

patient had a rapid and normal convalescence and was able to return to his work in a few weeks.

Prolapse of the Kidney through a Wound.—Wounds in the lumbar region below the ribs, if of sufficient size, have been followed in a number of instances by total or partial prolapse of the kidney; the kidney may or may not be injured. The prolapse has occurred at once from increased intra-abdominal tension, produced by coughing or vomiting, or at a later period. Constriction of the pedicle of the kidney by the wound margins, usually sufficient only to occlude the renal vein, causes swelling and congestion of the organ, profuse hemorrhage from an existent wound of the kidney itself, or, in other cases, hæmaturia. If the kidney remains unreduced, thrombosis of its vessels occurs, followed by gangrene. The diagnosis is to be made on inspection if the prolapse is complete; if partial only, digital exploration would at once reveal the characteristic shape of the kidney.

The Prognosis of Incised Wounds of the Kidney.—The prognosis of incised wounds of the kidney varies within wide limits, according to the presence or absence of complicating injuries. Simple incised wounds of kidney cortex heal well if not infected, usually *per primam.* Injury of the renal artery or vein is attended by such severe bleeding that speedy death results unless immediate surgical aid is at hand. Death from sepsis due to urinary infiltration, or from peritonitis, is common in untreated cases; a wound opening the renal pelvis or the peritoneum has probably been present in many of these. In some cases death has been due to nephritis; to uræmia from suppression of urine; in a few cystitis has been recorded as the cause of death.

Among 8 cases tabulated by Keen, 6 recovered and 4 died —1 from uræmia, 1 from sepsis and abscess of the liver. In 12 cases reported by Edler death occurred in 5, and was due to primary bleeding twice, twice to secondary bleeding, in 1 death followed nephrectomy. Among Keen's cases, 4 were treated by nephrectomy; all recovered. Küster collected 43

cases with 10 deaths; among these cases many had severe complications. Of 31 uncomplicated cases, but 4 died. The prognosis is profoundly modified by prompt and efficient treatment and, on the other hand, by neglect.

GUNSHOT WOUNDS OF THE KIDNEY.

Bullet wounds of the kidney uncomplicated by other serious injuries are rare; the renal vessels, the pleura, lung, diaphragm, liver, stomach, spine, etc., are very commonly injured as well; such wounds are so rapidly fatal that, when received in battle, they rarely come under treatment. The explosive effect of the high-powered rifle bullet is well marked on the kidney; the organ is often found torn in all directions or reduced to a pulp; even wounds from pistol bullets show a considerable degree of laceration of kidney tissue. Simple perforations from high-powered rifle bullets are only seen at extreme ranges. Among the cases of pistol-shot wounds, if the bullet merely grooves the cortex, or if the injury is confined to the cortex, the prognosis is much better than though the pelvis and the renal vessels are injured. Small pistol bullets fired at low velocities may perforate the kidney without producing very serious damage, and a number of such cases have, undoubtedly, recovered without operative interference.

In the simpler forms of gunshot wound of the kidney hemorrhage is not usually very profuse. The dangers are shock from complicating injuries; hemorrhage from injuries of the renal vessels, sepsis from wound infection, caused by unclean manipulations of the wound, from extravasation of urine, from the entrance of foreign bodies—*i.e.*, portions of clothing along with the bullet; from an ascending infection caused by imperfect asepsis in catheterization, the production of cystitis and infection of one or both kidneys.

The number of recorded cases of gunshot wounds of the kidney in which no other important structure has been wounded is not very large. In warfare the frequency of gunshot wounds of the kidney was estimated by Edler, and independently by Küster, at 0.12 per cent. of all wounds. Statistics

compiled from a number of sources indicate that penetrating gunshot wounds of the abdomen involve the kidney in about 7.3 per cent. of the cases. The following statistics give some idea of the mortality in gunshot wounds of the kidney.

In the American Civil War 85 such wounds were followed by 26 recoveries and 59 deaths—a mortality of 69.41 per cent. In the Franco-Prussian War, among 15 gunshot wounds of the kidney there were 8 deaths and 7 recoveries—a mortality of 53.33 (Küster). These results represent wounds from large soft-lead bullets in pre-antiseptic days. The prognosis of wounds of the kidney occurring in civil life, such being, for the most part, pistol-shot wounds, is notably better; thus, Küster collected 29 such cases, with 21 recoveries and 8 deaths—a mortality of 28.41 per cent. The prognosis is, as already stated, profoundly modified by associated injuries.

Experiences gained in recent wars seem to show that uncomplicated wounds of the kidney produced by small-calibre rifle bullets at long ranges may be simple perforations, and so long as they do not open the pelvis or injure the renal vessels may heal without operative interference and without trouble. It is to be borne in mind that though no serious bleeding may occur immediately, the separation of the eschar produced by the bullet, at the end of five to ten days, may be followed by serious or even fatal secondary hemorrhage, evidenced by profuse hæmaturia or by the formation of a perirenal hæmatoma, or by bleeding from the external wound. In some cases the colon has been wounded and the blood has escaped *per rectum*. Infection and perirenal suppuration are quite prone to occur; a certain number of instances of this kind have been observed as the result of the passage of a foreign body, usually a piece of cloth, into the wound, and, in a few instances, such fragments of cloth have eventually been passed *per urethram* after months of perirenal suppuration, pyelitis, and cystitis.

Diagnosis of Gunshot Wounds Involving the Kidney.—The diagnosis of gunshot wounds involving the kidney may sometimes be made from the objective signs of injury of the kidney, as already described; in other cases the symptoms will

be those of shock and intra-abdominal bleeding, as in stab and incised wounds. The cardinal signs are *hæmaturia* and the *escape of urine* from the external wound. Owing to the narrow wound of entrance, this latter sign is much less common in gunshot injuries. If the ureter is plugged by a clot, severe renal colic may be present.

In gunshot wounds involving the abdominal viscera, operated upon for the control of bleeding or for the repair of wounds of the hollow viscera, it will be rare that the surgeon can diagnosticate injury of the kidney before opening the abdomen, unless hæmaturia or kidney colic have existed. The anatomical site of the wound and the direction of the wound canal may aid in the diagnosis, notably when made by a small-calibered jacketed rifle bullet, since, as stated elsewhere, these bullets pursue a straight course through the body. The track of a soft-lead pistol bullet through the tissues, on the other hand, can only be surmised, deflection being caused by bones, tendons, and fascial planes in a large proportion of cases. The location of a lodged bullet may be determined by means of stereoscopic radiographs or with one or other form of localizer; such measures might possibly locate a bullet lodged in the kidney, but would scarcely be of much diagnostic aid in ordinary cases.

THE SURGICAL CONCEPTION OF PANCREATITIS.*

BY CHARLES N. SMITH, M.D.,

OF TOLEDO, OHIO,

Gynæcologist to St. Vincent's Hospital.

THE surgery of the pancreas has, until quite recent years, consisted in the rather infrequent incision and drainage of pancreatic cysts and the drainage of effusions into the lesser peritoneal sac, the so-called pseudocysts of the pancreas. At the present time, however, there is rapidly coming a better understanding of pancreatic disease, and, owing to the investigations and writings of Robson, Moynihan, Cammidge, Opie, and others, not only the importance and the prevalence of inflammatory diseases of this essential and dual organ, but also the means of diagnosis of these conditions, are becoming more generally appreciated and are gaining the attention which their importance demands.

The frequent occurrence of cholelithiasis as the essential etiological factor in pancreatitis demands most thoughtful consideration, as must the fact that pancreatitis may eventually become an incurable condition, or, by extension of the inflammatory process to the islands of Langerhans, result in intractable diabetes. A more general recognition of these facts cannot do otherwise than stimulate the profession to earlier and more frequent surgical removal of gall-stones, as a prophylactic measure aimed against a probable pancreatitis and a possible diabetes.

Introductory to a presentation of the surgical conception of pancreatitis, certain rather elementary statements concerning the surgical anatomy and relations of the pancreas will assist in the ready grasp of the main points at issue, which fact must serve as an excuse for presenting them at this time.

The pancreas, a long, narrow, lobulated organ, from five

* Presidential Address delivered before The Academy of Medicine of Toledo and Lucas County, December 4, 1908.

to six inches in length, extending from the concavity of the second and third portions of the duodenum to the inner border of the spleen, is situated mainly in the epigastrium, behind the stomach and the lesser peritoneal cavity. Its head is not only intimately connected with the duodenum, enveloping about one-third of the circumference of that organ, but the upper portion of its anterior surface is also attached by areolar tissue to the transverse colon. The narrow, constricted portion of the pancreas, known as the neck, is in contact with the first portion of the duodenum and with the pylorus whenever the stomach is distended.

The anterior surface of the body is covered by peritoneum, forming the posterior wall of the lesser peritoneal sac, lying between it and the stomach, while the posterior surface of the entire organ is devoid of peritoneum, being directly attached by areolar tissue to the posterior abdominal wall and to adjacent organs and structures. The posterior surface of the head is channelled by a groove, or pierced by a canal, in which lies the common bile-duct.

The main secretory duct of the gland, the duct of Wirsung, having its origin from small radicles in the tail, passes transversely toward the right through the body, but as it enters the head it swerves backward and downward until it comes into rather close contact with the common bile-duct, and together these two ducts penetrate the wall of the second portion of the duodenum and open into its lumen about four inches below the pylorus. A second or subsidiary duct, the duct of Santorini, draining only the head of the pancreas and being of functional importance in less than fifty per cent. of individuals, opens as a rule into the duodenum from three-fourths of an inch to an inch above the opening of the duct of Wirsung. Occasionally the secondary duct empties into that of Wirsung a short distance above the junction of the latter with the common bile-duct, or it may open by one extremity into the duodenum and by the other into the duct of Wirsung.

A rare but, from a surgical standpoint, an important anomaly of the pancreas consists in the complete investment of the

duodenum by the head of the pancreas. Enlargement or distortion of the head under such a condition, by either new growth or inflammation, may so encroach upon the duodenum as to produce obstruction of the bowel, attended by the symptoms of pyloric obstruction. A more common, but still rare, anomaly is the occurrence of an isolated mass of pancreatic tissue, generally situated in the muscular layer of the wall of the small intestine and opening into the lumen of the bowel by an individual duct.

The infections of the bile-tract, either with or without the presence of gall-stones, are such important etiological factors in pancreatitis that a study of the relations of the common duct to the pancreas and its excretory duct materially assists in arriving at our conception of the surgical nature of pancreatitis. The first and second, the supraduodenal and the retroduodenal portions of the common bile-duct possess no anatomical relations of importance in connection with pancreatitis, but the relations of the third, or pancreatic portion, and the fourth, or intraparietal portion, lying within the structures of the wall of the duodenum, are of the greatest etiological importance.

According to Helly, the pancreatic portion of the duct, which is in contact with the pancreas for a distance varying from 2 to 7 cm., ran in a canal completely surrounded by pancreatic tissue in 62.5 per cent. of the cases examined by him, while it ran through a groove on the posterior surface of the gland in but 37.5 per cent. In 58 subjects examined by Bunger, the bile-duct was completely covered by glandular tissue in 55 and ran uncovered in a groove in 3 only. Moynihan dissected the pancreatic portion of the common bile-duct in 20 cases and found the duct completely covered in 13 and lying in a deep groove, overlapped, but not completely covered, by pancreatic tissue in 7 only. The important bearing of these varying relations of the bile-duct to the pancreas becomes at once apparent in the consideration of possible obstruction of the common duct due to the pressure of the swollen head of the gland in pancreatitis and in malignant disease. Swelling of

the head of the gland is certain to seriously impede, if not obstruct, the outflow of the bile in that large proportion of cases in which the lobules of the gland completely surround the bile-duct, while the latter structure is as sure to escape compression by being displaced to one side when more fortunately, although less frequently, situated in a groove uncovered by pancreatic tissue.

In October, 1908, I operated upon a case of chronic pancreatitis, secondary to cholelithiasis, with that profound stationary jaundice so characteristic of pancreatic obstruction, as contrasted with the ebb and flow of the jaundice in obstruction of the common duct by stone, in which a painstaking examination of the bile-ducts proved the absence of stone in the common duct, but showed that the duct was entirely surrounded by pancreatic tissue, the enormous swelling of which had completely obstructed its lumen.

In another case of chronic pancreatitis, secondary to cholelithiasis, operated upon November 4, 1908, for Drs. Reynolds and Rohne of Defiance, in which there was no jaundice, with no stone in the common duct, but with 4 stones in the cystic duct and 53 in the gall-bladder, there was swelling of the head of the pancreas almost as great as in the above-mentioned case, but with absolutely no obstruction of the common duct. Evidently the pancreatic portion of the duct in this case was either in a groove on the surface of the gland or, at least, too superficially situated to be affected by the glandular swelling. Access to the head of the pancreas, in each case, was gained by mobilization of the duodenum as in Kocher's gastroduodenostomy, with inward displacement of the duodenum and lifting forward of the head of the pancreas.

The various modes of termination of the common bile-duct and the pancreatic duct in the duodenum are of great interest in this connection. Four distinct modes of termination are described by Letulle and Nattan-Lorrier, although there is but slight practical difference between the third and fourth. In the first, which is the usual mode of termination, the common bile-duct, lying above, and the pancreatic duct, lying below,

unite to form a common, oval-shaped canal in the wall of the duodenum, the ampulla of Vater. The duodenal opening of the ampulla is the narrowest portion of the bile-tract, having an average diameter, according to Opie, of but 2.5 mm. In the second mode of termination the two ducts unite before reaching the duodenum, forming a common canal or duct opening into the duodenum by a small, flat, elliptical opening, no ampulla being present. In the third type, the two ducts open side by side into a depression or fossa in the wall of the duodenum; while in the fourth, the independent orifices of the ducts open at the summit of an elevation or caruncle. No ampulla is present in this type. In the later consideration of pancreatitis secondary to cholelithiasis, with the presence of a stone in the ampulla, or in the distal extremity of the common duct, the importance of the mode of termination of the bile- and pancreatic-ducts will become apparent.

As has been shown above, the head of the pancreas is in intimate relation with the duodenum and, naturally, it may be seen that either inflammation or malignant disease of the one may involve the other.

The close relation of the stomach, especially the pyloric portion, the favorite site of gastric cancer, with the pancreas, makes possible the secondary involvement of the pancreas in cancer of the former, a condition which, of course, contraindicates a gastrectomy which otherwise might be indicated. This was strikingly illustrated in a case operated upon by me a few weeks ago, in which a partial gastrectomy for cancer of the lesser curvature of the stomach, with no apparent symptoms of pancreatic involvement, seemed to be indicated until operative exploration disclosed, not only adhesion of the stomach to the pancreas, but also the involvement of the latter organ in the malignant process.

Adhesions between the stomach and the pancreas resulting from disease of either organ, as in ulcer of the one or inflammation of the other, not only materially complicate the indicated operative procedure, but also add greatly to the rate of operative mortality. These results are especially evident in

malignant disease of the stomach involving the pancreas. Mikulicz found in 91 partial gastrectomies with no operative injury to the pancreas, a mortality of 27.5 per cent., but a mortality of 70 per cent. in 30 cases in which the pancreas was injured or in which, from operative necessity, a portion of the pancreas was removed. The lesson to be drawn from his experience and deductions is self-evident.

Ulcer of the posterior wall of the pyloric portion of the stomach, especially when approaching a condition threatening perforation, may lead to adhesions between the stomach and pancreas with subsequent secondary infection of the latter. Mayo Robson reports an interesting case, in which ulcer of the stomach, by adhesion and extension of infection to the pancreas, provoked an acute pancreatitis, with the subsequent formation of a pancreatic abscess which eventually ruptured into the stomach and was cured by stomach and pancreatic drainage by means of a gastrojejunostomy.

Operative procedures on the stomach necessitating the separation of adhesions between it and the pancreas, the result of gastric ulcer, must be conducted with the greatest regard for the preservation of the integrity of the pancreas, as the chances of a successful operative issue diminish in inverse ratio to the amount of injury to the pancreas.

The fact that the peritoneum, reflected over the anterior surface of the pancreas, forms the posterior wall of the lesser peritoneal cavity, is of the utmost surgical importance. Much confusion has arisen over the pathology of, and the differential diagnosis between, true pancreatic cysts and effusions of fluid into this lesser peritoneal sac, the so-called pseudocysts of the pancreas. Jordan Lloyd, in 1892, called attention to the differences distinguishing the two conditions, and yet to-day we read case reports of the two conditions, hopelessly confounded, in the same paper and under the same title. The employment of the term "pseudocyst of the pancreas" is unfortunate because misleading and begetting a false idea in pathology. True cysts originate within the glandular tissue of the organ itself and are covered with, and separated from the lesser peritoneal

cavity by, the layer of peritoneum covering the anterior surface of the pancreas. Effusions of fluid into the lesser peritoneal cavity, while they may result from injury or disease of the pancreas, are entirely, originally and ultimately, outside of that organ and separated from it by peritoneum. The differential diagnosis between the two conditions is difficult and at times impossible. Owing to this fact, to mistaken ideas in pathology, and to faulty deductions from necessarily hasty and incomplete investigations upon the operating table, unquestionably many cases of effusion into the lesser peritoneal sac are reported in the literature of pancreatic disease, classified as true cysts of the pancreas.

A most interesting case of effusion into the lesser peritoneal sac was referred to me for operation by Drs. Sharpe and Grosh. From a slight elevation of the abdominal wall over the stomach, present when first seen, this patient developed in four day's time an enormous fluid distention of the entire upper central abdominal cavity. A history of preceding attacks of biliary colic and the presence of a mild degree of jaundice led to a diagnosis of pancreatitis secondary to cholelithiasis with, owing to the rapid increase in size of the abdominal swelling, an effusion into the lesser sac, probably hemorrhagic in nature. Operation showed the lesser sac to be distended with blood, bile, and pancreatic fluid. Two moderate-sized gall-stones and the disintegrated remains of others were removed from the lesser cavity well over to its left extremity. The common bile duct and presumably the duct of Wirsung were ruptured. There was positively no history of trauma in this case. Under free drainage the patient slowly but steadily recovered.

Histologically considered, the pancreas is a compound tubular gland, the branching ducts terminating in tubular acini. A small collection of secreting glands, held together by fibres of connective tissue, form a primary lobule. The grouping together of a number of primary lobules constitutes a secondary lobule, and a further grouping gives a large tertiary lobule, just discernible by the naked eye. The lobules are supported by connective tissue, both interlobular and intralobular. These are the secreting structures from which flow the digestive or

external secretion of the pancreas, which is collected by the pancreatic duct and by it poured into the duodenum.

Langerhans, in 1869, described certain ovoid groups of cells, either distinctly or irregularly polygonal in shape, irregularly placed in the intralobular structures of the pancreas and having no connection whatsoever with the pancreatic duct or its radicles, nor possessing any form of excretory duct. These are the islands of Langerhans, which elaborate the internal secretion of the gland, which controls the metabolism of the carbohydrates.

Thus the pancreas is a dual gland, with two distinct and separate secreting structures, each elaborating its own peculiar secretion. While the external secretion is the most important and the most effective of the digestive fluids, its function may be carried on, under necessity resulting from pancreatic disease, by other digestive fluids and by the intestinal bacteria; but the internal secretion from the islands of Langerhans has, in the light of our present knowledge, no proven assistant, unless it be the glands of Brunner in the duodenum, and inhibiting or destructive disease of these insular structures at once results in an arrest of carbohydrate metabolism. If the contentions of certain recent investigators prove true, to the effect that lesion of the islands of Langerhans is the result, rather than the cause, of diabetes, then must we rewrite the pancreatic pathology of diabetes. For the purposes of this paper, the pancreatic origin of diabetes is accepted without prejudice to the claims of these recent writers.

Frequent and deliberate detailed study of the pathology of pancreatic disease is beset by many difficulties, chief among them being the fact that post-mortem changes, including an apparent autodigestion, occur with a rapidity so extreme as to preclude satisfactory pathological examination, either macroscopical or microscopical, at autopsy. It is due to the rapidity and the pronounced degree of these changes, indeed, that not only the nature of existing pancreatic disease has been misinterpreted, but also that its actual presence has been so generally overlooked in the routine post-mortem examinations in our

large hospitals and public institutions. Mayo Robson, in referring to the rapidity of these changes, impressively says: "Only those who have seen and handled an inflamed pancreas can realize how an engorgement and swelling of the gland which was perfectly evident at the time of operation may, if the organ is examined a few hours later on the post-mortem table, have entirely disappeared, leaving a structure which is pale and flaccid, presenting, in fact, no marked deviation from the normal." It is from the surgeons, operating especially for gall-stones and the diseased conditions allied therewith, that the greater portion of our knowledge of pancreatic pathology in the human being has been obtained. Necessarily, the investigations of surgeons during the course of operations cannot be conducted with that thoroughness and deliberation attendant upon laboratory examinations, nor can sections of the pancreas be removed for subsequent microscopical examination, owing to the ulterior results arising from wounds of this organ.

In view of all these difficulties, our knowledge of pancreatic pathology is, as yet, considerably confused, and the literature of the subject contains many conflicting statements and theories. The one great fact of general acceptance, however, which stands out pre-eminently in this mass of confusion, is that practically all the important diseased conditions of the pancreas, including malignant disease, fatty degeneration, lesion of the islands of Langerhans resulting in intractable diabetes, true retention cysts, effusions into the lesser peritoneal cavity, profound and fatal intrapancreatic and extrapancreatic hemorrhages, and pancreatic calculi, are, in many instances at least, dependent upon a pre-existing pancreatitis, either acute or chronic, and that this causal pancreatitis is frequently associated with, and etiologically dependent upon, concretions within the biliary tract or the concomitant infection incident thereto or resulting therein.

Another point of decided surgical interest, concerning the occurrence of which there can be no differences for discussion, relates to the frequency, as yet scarcely appreciated, of hemor-

rhage, either mild or severe, into the substance of the pancreas, or immediately beneath the peritoneum on the anterior surface of the organ, resulting in a bulging encroachment upon the lesser peritoneal sac, or of hemorrhagic effusion into the lesser sac itself, these hemorrhages being incident to the course of a pancreatitis. The comparative ease with which the pancreas may be injured and hemorrhage provoked must constantly be borne in mind when operating upon structures adherent or contiguous to the pancreas, and particularly when exploring the distal extremity of the common bile-duct. This possibility of traumatic hemorrhage, as in that of spontaneous or non-traumatic hemorrhage, is considerably increased if pancreatitis, or malignant disease of the pancreas, either with or without jaundice of pancreatic origin, be present, owing to the marked urinary elimination of the lime salts of the blood in the course of a pancreatitis, materially interfering with and delaying the time of blood coagulation.

This tendency to hemorrhage in pancreatic disease is rather frequently shown in the occurrence of hemorrhage in the body structures apart and distant from the pancreas. One of my recent cases had many repeated hemorrhages into the skin, giving the appearance of severe contusions, a point which was of decided diagnostic value, as these petechial hemorrhages are by no means rare in the course of a pancreatitis. Moynihan observed, in one case of cancer of the head of the pancreas, severe and repeated hemorrhages from the bowel, and others have reported extreme and even fatal hemorrhages within the abdomen but apart from the pancreas, during a pancreatitis.

Pancreatitis can be provoked experimentally in animals by either chemical, mechanical, or bacterial agencies. In man, clinical observations but corroborate the deductions from animal experimentation, while the anatomical arrangement of structures brings into close relation with the pancreas not one only, but all, of the possible causal agencies. In the bile flowing through the common duct and, under favorable circumstances, liable to retrojection into the pancreatic duct, is

found the chemical agent. The presence of gall-stones in the ampulla of Vater, or in the pancreatic portion of the common duct, exerting obstructive pressure upon the duct of Wirsung, affords the mechanical agent. The existence of bacteria in the ducts of Wirsung and of Santorini, in the common bile-duct and in the duodenum, all of which structures freely communicate, furnishes the third, which might well be called the explosive agent.

That the injection of bile or bile salts into the pancreatic duct in lower animals will cause an acute pancreatitis, has been conclusively shown by Opie and others. Flexner has carried these experiments further, demonstrating that the intensity of the pancreatic inflammation is dependent upon the concentration or dilution of the salts in the bile. Pure bile, undiluted by mucus, invariably produced an acute pancreatitis, while bile containing a large increment of mucus, as found in chronic inflammatory diseases of the bile tract, produced a chronic pancreatitis.

Opie reports the autopsy findings of a most interesting case of acute pancreatitis in man, in which a small gall-stone, lodged in the ampulla of Vater, while too small to obstruct the opening either of the common duct or of the duct of Wirsung into the ampulla, was still sufficiently large to obstruct completely the outlet of the ampulla into the duodenum. Bile, unable to escape from the ampulla into the duodenum, overcoming the intrapancreatic pressure, was retrojected into the pancreas through the duct of Wirsung, as was shown by the deep staining of the duct walls. In this case all conditions necessary to the production of an acute pancreatitis were present—the chemical irritant in the bile, the mechanical obstruction by the impacted gall-stone, the bacteria from pancreatic and bile-ducts powerful to infect the pent-up secretions and the tissues made less resistant by the pressure therefrom. That this peculiar form of obstruction cannot frequently occur is granted, yet the presence of a gall-stone in the ampulla, necessitating a transduodenal choledochotomy, is by no means rare, a number of such cases having come under my own observa-

tion; and it is fair to suppose that, while the majority will by pressure produce complete obstruction of the common duct, a small proportion will allow the reflux of bile into the pancreas.

Experimental obstruction of the pancreatic duct by ligature has repeatedly produced pancreatitis in animals, and we see the analogue in man in the cases of practically complete obstruction of the duct of Wirsung by a gall-stone lodged in the pancreatic portion of the common duct or in the ampulla of Vater; and it is this calculous obstruction which is, comparatively speaking, so frequently found associated with and productive of pancreatitis. Following the obstruction, an infection of the imprisoned fluids, of the structures of the duct, and, eventually, of the gland itself, ensues and continues as long as the obstruction remains.

When, as described in the early part of this paper, the common duct and the pancreatic duct unite to form a common channel some distance before opening into the duodenum, not only is the outflow of pancreatic fluid arrested by the impaction of a gall-stone in this common channel, but also the retrojection of bile into the pancreas is rendered unavoidable.

It is to Robson that we are indebted for the first exposition of the fact that pancreatitis is so frequently dependent upon cholelithiasis and so generally amenable to surgical treatment, primarily directed toward the gall-stones and the attendant cholangeitis. Recording his own experience, he states that he has found pancreatitis present in about 60 per cent. of the cases in which gall-stones were present in the common duct. The Mayos found 81 per cent. of their cases of pancreatic disease to be the result of or coincident with gall-stones. Deaver reports that the majority of his cases of chronic pancreatitis occurred in patients in whom no gall-stones were present at the time of operation, but in whom there were indubitable evidences of infection of the gall tract resulting in cholangeitis, cholecystitis, or pericholecystic adhesions.

It has been shown that, in an uncertain number of instances, the duct of Santorini opens by one extremity into the duodenum and by the other into the duct of Wirsung. Desjardins

has proven that the duct of Santorini, when patent and normally situated and related, is but a tideway, the direction of the current through it changing from time to time, now flowing from the pancreas into the duodenum and again in a reverse direction from the duodenum into the duct of Wirsung and the pancreas. This reverse current carries with it bacteria from the duodenum through the head of the pancreas and pours them into the duct of Wirsung where, meeting the outbound current in that duct, they are returned to the duodenum by another route through the head of the pancreas. Infection of that portion of the pancreas lying in the triangle bounded by the two ducts and the duodenum is thus rendered possible.

Williams and Bush, basing the deduction upon anatomical study and experimental investigation, suggest "that some cases of acute pancreatitis may be caused by regurgitation of duodenal contents into the diverticulum of Vater, the way having been opened by the passage of gall-stones."

Maugaret contends that pancreatitis following cholelithiasis is not the result, either directly or indirectly, of an intestinal infection; that the infection does not invade the pancreas through the ducts, because of the bactericidal power of the pancreatic juice and the rapidity of the out-current in the ducts; that in very exceptional cases only does the infection extend to the pancreas by contiguity; that infection of the gall-bladder is the one constant condition in associated cholelithiasis and pancreatitis; and that infection is carried from the gall-bladder to the pancreas by the efferent lymphatics of the gall-bladder which terminate in the lymphatic glands at the head of the pancreas, which also receive the efferent lymphatics from the pancreas.

The interstitial changes occurring in the course of a chronic pancreatitis present two distinct types which, depending upon the relative location of the fibrosis, have been termed by Opie the interlobular and the interacinar. In the interlobular form of the disease the fibrosis, primarily between the lobules and not then affecting the intralobular structures, gradually ex-

tends inward from the periphery of the lobules. The affected portion of the gland is given a more distinct appearance of lobulation, and, because of the marked increase of connective tissue, it becomes decidedly enlarged and hard and unyielding to the touch. It is not until late in its progress that the morbid process involves the islands of Langerhans and diabetes supervenes.

The interacinar type is marked by the formation of a network of fibrous tissue within the lobules and surrounding the glandular acini. Involvement of the islands of Langerhans, with the resultant diabetes, is an early event in this form of pancreatitis. The interlobular structures are affected but slightly, if at all, and the affected portion of the pancreas does not usually become nodular, but remains uniformly smooth.

Because of the fact that 62 per cent. of the cases of cancer of the pancreas occur in the head of the organ, because cancer results in decided enlargement, distinct lobulation, and marked hardening of the glandular structures, and because surgeons have failed to recognize that in many instances the enlargement, lobulation, and hardening of the head of the gland was inflammatory, many cases of chronic pancreatitis of the interlobular type have been mistaken for cancer. Attention was first called to this point by Robson in 1900, and his contention has since been verified by a number of operators.

Blocking of the pancreatic duct by pancreatic calculi has been mentioned by some authors as a cause of pancreatitis. Reasoning from the premise that obstruction of the pancreatic duct will result in pancreatitis, this deduction would seem to be justifiable. However, Pende has shown that experimental aseptic ligation of the pancreatic duct will result in the formation of pancreatic calculi having the same chemical composition as the calculi found in man, while Galippe and Guidiceandra have demonstrated the presence of bacteria in pancreatic calculi. It would seem the more correct reasoning, to hold that a pancreatitis, of obstructive and bacterial origin, preceded and was the active factor in the formation of calculi; or that the development of a pancreatitis and the formation of

calculi were synchronous phenomena resulting from the same cause; and that, in either event, the two conditions later became correlated, the obstruction and irritation of the ducts by the calculi still further aggravating the pancreatic inflammation.

That obstruction of the common bile-duct may occur without subsequently provoking a pancreatitis would seem, at first thought, to invalidate some of the contentions herein advanced. Reference, however, to the anatomical relations existing between the common bile-duct and the head of the pancreas, and to the relations between the common and pancreatic ducts, to the methods of termination of the ducts at their duodenal orifices, and to the functional importance of the duct of Santorini, at once explains this seeming discrepancy. As has been shown by Helly, the common duct lies in a groove, uncovered by pancreatic tissue, in 37.5 per cent. of individuals. Naturally, a gall-stone lodged in a common duct running in such a groove, exerting its pressure in the line of least resistance, would fail to compress a pancreatic duct embraced in the substance of the pancreas and, consequently, would not act as a mechanical cause of pancreatitis. When, as in the third and fourth divisions of Letulle's classification, the common duct and the pancreatic duct open into the duodenum by separate but adjacent orifices, a gall-stone obstructing the bile-duct could scarcely occlude by its pressure the pancreatic duct. Again, in a certain small proportion of cases, the duct of Santorini is the main excretory duct of the pancreas, while in others, although of secondary importance, the fact that it opens into the duodenum by one extremity and frequently anastomoses with the duct of Wirsung by the other, enables it to furnish an efficient outlet for the pancreatic fluid when the duct of Wirsung is compressed by a concretion in the common duct, and so annul the otherwise etiological power of obstruction of the latter. However, as the common duct runs through the head of the pancreas, being completely embraced by the gland, in 62.5 per cent. of all individuals, bringing it into close relation with the pancreatic duct, and as the common

duct and the pancreatic duct open into a diverticulum of Vater in the majority of cases, the opportunities for obstruction of the pancreatic duct by gall-stones are indeed great.

As regards the etiology and pathology of retention cysts of the pancreas, the evacuation and drainage of which has to so large an extent constituted the pancreatic surgery of the past, some uncertainty still exists. The late Nicholas Senn advanced the reasonable hypothesis, that as intermittent and not permanent obstruction of the ureter resulted in hydronephrosis, so an intermittent obstruction of the pancreatic duct might produce a retention cyst of the pancreas. Cysts of the pancreas and pancreatic calculi are frequently found associated, but the association is not a correlation, as neither is etiologically dependent upon the other, but both are equally dependent upon a common underlying pathological condition. In the opinion of Robson, chronic pancreatitis is frequently and commonly this underlying condition.

The diagnosis of pancreatitis, either acute or chronic, is not difficult if advantage is taken of all the methods of diagnosis now available. Some of these essential diagnostic procedures are, however, laborious and time-consuming. In the past, difficulties arose because of the slight evidences of digestive disturbances in pancreatic disease, owing to the fact that other agencies were capable of taking on, to a large extent, the functions of the pancreatic fluid. Further difficulties arose from the almost universal association with pancreatitis of morbid processes in the bile tract, the stomach, or the duodenum, the symptoms of the associated processes being at times impossible of differentiation. At the present time, the information obtained from the physical, chemical, and microscopical examination of the fæces and urine, in addition to other signs and symptoms, makes possible the differentiation of the symptoms attributable to each of the associated processes and renders the diagnosis of an existing pancreatitis a certainty.

The digestive disturbances attending a pancreatitis are too indefinite to be of diagnostic value. Loss of appetite, with a particular distaste for meats and fats, is frequently noticed.

Vomiting is a common symptom in acute pancreatitis and an uncommon one in the chronic disease. The valuable symptoms arising from faulty digestion are found in the altered condition of the fæces. The fecal evacuations in pancreatic disease are frequent, soft, bulky, and pale. One of my patients had, regularly, from three to four large, soft evacuations daily. Patients will frequently complain of diarrhœa, but investigation will generally show that the term has been misapplied, it having been used because the stools were large, soft, and frequent. The importance of this symptom is greatly increased if jaundice is present. In cancer of the pancreas this symptom is not so common as in pancreatitis. In some instances, especially if the ingestion of fats is not diminished, the stools are distinctly greasy. The large size of the stool is the result of incomplete digestion, especially of albuminous foods. The frequency of the evacuations is due to their increased bulk. The normal pigmentation of the fæces being due to the presence of an insoluble pigment resulting from the action of the pancreatic juice upon some of the coloring matters of the bile, it necessarily follows that absence from the bowel of either pancreatic juice or bile will result in unpigmented fæces.

Azatorrhœa, or the presence in the fæces of a marked and unusual quantity of undigested muscle-fibres, is a valuable symptom in pancreatic disease, but is more strongly suggestive of malignant disease than of inflammation. While the undigested meat-fibres may occasionally be detected by the naked eye, a microscopical examination is generally necessary. In weighing the exact diagnostic value of azatorrhœa, the habits of the patient as regards the quantity of meats ingested must be taken into consideration, as undigested muscle-fibres can be found in the fæces of healthy individuals who habitually partake freely of meats.

Steatorrhœa, fat in the fæces, has long been recognized as a symptom of pancreatic disease and is a more trustworthy symptom than is azatorrhœa. Although in some cases of pancreatic disease the fæces are visibly greasy, the presence or absence of steatorrhœa must not be presumed, ordinarily, from

the visual appearance of the stool, but must be determined by a thorough chemical examination. As confirmatory of the pancreatic origin of steatorrhœa, in any given case, the marked diminution in the quantity of fat in the stools following the administration of pancreatic extract is of considerable value.

In the presence of an enteritis, during which ingested materials are hurried through the intestines with more than normal rapidity, both azatorrhœa and steatorrhœa may be present with no pancreatic lesion. This possibility, as well as the habits of the patient as regards the ingestion of fats and meats must be given due weight in arriving at a diagnosis.

The existence of pancreatic disease having been established, the differential diagnosis between cancer and inflammation of the organ immediately assumes importance. Again, resort must be had to chemical examination of the fæces, for purposes of differentiation. In cancer of the head of the pancreas owing to the complete or nearly complete exclusion of the bile from the intestine, resulting from the obstructive gripping of the common bile-duct by the malignant growth, the fæces will be found free from or showing but the slightest trace of stercobilin. In obstruction of the common duct by gall-stone, or in swelling of the head of the gland in chronic pancreatitis, however, the obstruction to the outflow of bile is rarely either absolute or continuous, and stercobilin will be found in the fæces, although in diminished quantity.

Cammidge's pancreatic reaction when obtained in the urine is strongly, if not absolutely, confirmatory of the diagnosis of pancreatitis. No one symptom is so reliable as is this and, when considered in connection with the results obtained from examination of the fæces, it proves of inestimable value. It is, technically, somewhat difficult and tedious of performance, and technical errors must be absolutely excluded, as otherwise failure to obtain the reaction will result in an incorrect diagnosis. The technic of the test is too long and too complicated to warrant its presentation in this connection. While this reaction can be obtained in practically all cases of pancreatitis, it will be obtained, also, in about 25 per cent.

of the cases of cancer of the pancreas, owing to an associated pancreatitis. This possible error in diagnosis can be corrected by examination of the fæces for stercobilin, the absence of the latter in the presence of the pancreatic reaction indicating the existence of cancer of the pancreas.

Loss in weight, due to digestive disturbances and to derangements of internal metabolism, is a rather constant and important symptom of pancreatitis, yet it may not be marked or may be entirely absent. Taken in connection with other symptoms, this loss of weight is strongly confirmatory evidence of either inflammation or malignant disease. As would naturally be expected, it is present to a more marked degree in the latter.

Jaundice in the course of a pancreatitis may be of either biliary or pancreatic origin. The former results from obstruction of the common duct by stone without interference with the outflow of the pancreatic secretion. The latter, far more frequent than the former, may be occasioned by either a catarrhal panereatitis so frequently resulting from a duodenal infection, or by compression of the common duct as it courses through the head of the pancreas, such compression being due to the enlargement of cancer or the swelling of inflammation.

Courvoisier's law that: " In cases of chronic jaundice due to blockage of the common duct a contraction of the gall-bladder signifies that the obstruction is due to stone; a dilatation of the gall-bladder, that the obstruction is due to other than stone," finds abundant proof in cases of pronounced pancreatic jaundice. That this law has been so distorted by some writers as to convey the impression that with dilatation of the gall-bladder the obstruction is due to cancer of the pancreas, is most misleading and unfortunate. The swelling of the head of the pancreas incident to pancreatitis can as surely result in obstruction of the common duct as can cancer. Moynihan, in this connection, says: " In several cases I have seen a chronic indurative pancreatitis produce jaundice with an enlarged gall-bladder." In one of my own recent cases of obstruction of the common duct from pancreatitis, the distended gall-bladder measured seven inches in length.

In those cases in which the common duct runs along a groove on the head of the pancreas, where it is comparatively free from compression, neither pancreatitis nor cancer will result in jaundice.

The decided tendency to hemorrhage in the course of pancreatic disease, already referred to, need not again be mentioned, except to emphasize its importance as a diagnostic measure.

Pain and tenderness may be pronounced in all the forms of pancreatitis, or they may be at all times absent. In acute pancreatitis both are well marked and the pain may be agonizing in character. The point of tenderness is from an inch to an inch and one-half above and to the right of the umbilicus. In hemorrhagic pancreatitis the pain is frequently of a colicky nature and paroxysmal in occurrence. Each paroxysm of colicky pain probably indicates an additional hemorrhage. In chronic pancreatitis, pain and tenderness are not so strongly in evidence but are generally present. In my own cases, I have never failed to elicit tenderness at the above-mentioned point; and some of my patients, when told to point out the exact seat of pain, have accurately outlined the location of the pancreas from the concavity of the duodenum to the spleen.

Only in exceptional cases have I been able to outline a tumor at the site of the head of the pancreas, although occasionally it can be done. In acute pancreatitis, especially in the hemorrhagic form, the tumor is generally palpable by gentle flat-hand examination. In one case, in which there was marked gastroptosis, at least two-thirds of the pancreas was easily palpable. In the chronic form of the disease, however, the definition of a tumor is always difficult and frequently impossible.

Inflammation of the pancreas may occur as a process limited to the pancreatic ducts or as one involving the parenchyma of the organ, the first frequently being but initiatory to the second. Inflammation of the ducts is observed as either an acute or chronic simple catarrhal inflammation which may, unless resolution takes place, terminate in the more active and

dangerous form of suppurative catarrh of the ducts, or, by extension to the interstitial structures, eventuate in a chronic interlobular pancreatitis. Catarrh of the ducts may be caused by an infection from the duodenum in a duodenal or gastro-duodenal catarrh, from extension by continuity of a similar catarrhal process from the bile-ducts, or from obstruction of the pancreatic duct by a peripatetic gall-stone temporarily lodged in the pancreatic portion of the duct. Unquestionably, in many instances, the jaundice so generally called catarrhal jaundice and so generally attributed to infection or obstruction of the bile-ducts by stone, is due to catarrhal inflammation of the pancreatic ducts, the swelling of the head of the pancreas resulting therefrom encroaching upon the common duct and interfering with, but not arresting, the outflow of bile.

Should this simple catarrhal condition result in the suppurative form, the bile-ducts become involved by continuity of structure and a suppurative cholangeitis supervenes. More frequently, the cause not being removed, the infection continues mildly active and, invading the deeper tissues, results in a chronic pancreatitis.

That a primary catarrh of the ducts and, later, a secondary chronic pancreatitis may occur from infection from the bile tract without obstruction of the common duct by stone, must not be forgotten. While, in the great majority of instances, chronic pancreatitis is occasioned by obstruction of the pancreatic duct from pressure by a gall-stone with an infection of the imprisoned fluids, this obstruction is not an etiological necessity. Gall-stones in any part of the biliary tract, causing a cholangeitis, may be responsible for the occurrence of a pancreatitis. These facts are well shown by Deaver's experience, which has been the experience of others, in that in the majority of his cases of chronic pancreatitis no stone was found in any portion of the bile tract, although inflammatory conditions resulting from the irritation of stones sometime present were plainly evident. In these cases a stone may have been temporarily lodged in the common duct, occluding by pressure the pancreatic duct sufficiently long to produce a pancreatitis me-

chanically which continued after dislodgment and escape of the impacted stone.

The parenchymatous inflammations may be either acute, subacute, or chronic. Acute pancreatitis is essentially a hemorrhagic pancreatitis. Gangrenous or diffusely suppurative changes may be engrafted upon the hemorrhagic process. Considerable discussion has taken place concerning the relative incidence of the hemorrhage and the inflammation. Some operators contend that hemorrhage precedes inflammation, others that hemorrhage follows and is but incidental to the inflammation, while still others, as does Robson, believe that hemorrhage may, in some ultra-acute cases, precede inflammation, while in others it follows. From an operative standpoint these points of discussion, while interesting, are of but minor importance.

The symptoms of acute hemorrhagic pancreatitis are those of acute peritonitis involving the upper abdomen, and may readily be mistaken for those of perforation of the stomach or duodenum or of rupture of the gall-bladder. Pain, sudden, severe, paroxysmal, and increased upon movement, limited, in the early stages at least, to the epigastric region, is present. Tenderness is marked in the midline and to the right thereof, just above the umbilicus. Rigidity of muscle was absent, as a rule, in Moynihan's cases, but Ochsner notes it as present in his cases, while it was well marked in my own. Faintness and collapse are early evident and are later followed by vomiting of food, bile, and altered blood. Constipation is present but is more apparent than real, as bowel evacuation and the passage of flatus can generally be secured following the administration of enemata. The pulse is rapid, the rate steadily increasing from the onset of symptoms, as pointed out by Moynihan. The temperature varies considerably in different cases, ranging from a point below normal to one several degrees above. Opie states that " fever is rarely present until secondary changes have occurred in the diseased gland," the inference being that the temperature is due to these changes rather than to the pancreatitis itself. Cammidge's pancreatic

reaction can be obtained in the urine and may be the determining factor in a differential diagnosis. Moynihan says: "In two out of three cases upon which I have operated the most striking feature has been the general lividity of the skin; the face has looked suffused, the lips blue, and the body surface has been damp, cold, and leaden-hued." Opie and Ochsner have also observed cyanosis as a symptom, while Halsted has called attention to the cyanosis not only of the face but also of the abdominal wall.

A history of preceding attacks of gall-stone colic and a cholangeitis, attended in its later stages by jaundice, can almost invariably be obtained. This history taken together with the presenting symptoms makes a diagnosis of acute hemorrhagic pancreatitis strongly presumptive, and when Cammidge's pancreatic reaction is obtained, the diagnosis becomes positive.

Exploratory abdominal section is always indicated and must be performed early. In my own two cases of hemorrhagic pancreatitis a correct diagnosis was made in one case, and that of perforation of the duodenum from ulcer was made in the other. One, the first, was operated upon successfully, while the second died.

An uncertain number of cases of hemorrhagic pancreatitis are not attended by such pronounced and urgent symptoms, and they, naturally, offer a better prospect of success following surgical intervention. Collapse is not so marked, the pulse is neither so rapid nor so weak, nor does death ensue so quickly. These cases can well be classified as subacute.

The one great and essential feature in the surgical treatment of acute hemorrhagic pancreatitis is the provision for rapid, continuous, and abundant drainage. The method of approach to the pancreas must be determined by the conditions presenting when the abdomen is opened. The gastrohepatic omentum may be incised, as in my own cases, or entrance may be effected through the gastrocolic omentum. Approach through the mesocolon will scarcely ever be advisable because the subsequent drainage will be poor. Stab drainage in the costo-

vertebral angle may be advisable, especially in the cases attended by suppuration. Ordinarily, the necessity for this procedure will be obviated by careful exclusion of the general peritoneal cavity by gauze swabs during the performance of the operation and the employment of abundant gauze drainage subsequently. Puncture or incision of the engorged pancreas may be employed to advantage, but the hemorrhage resulting therefrom will certainly be profuse and difficult of control. The incision in the pancreas may be packed with gauze held in place by catgut stitches or it may be closed by catgut stitches alone. Care must be exercised in the control of this hemorrhage by suture that the secretory ducts of the pancreas be not included in the suture, otherwise an obstructive element is at once introduced which must, necessarily, greatly complicate the subsequent course of the disease. The general treatment of hemorrhage, shock, collapse, and infection must follow the customary methods.

The pathology, etiology, and diagnosis of chronic pancreatitis, having been sufficiently considered in the early pages of this paper, will not require further mention. The treatment of chronic pancreatitis is the surgical removal of the cause or causes. Gall-stones residing in any portion of the biliary tract must be removed, and efficient drainage provided and maintained until the existing infection has disappeared.

Gall-stones lodged in the ampulla of Vater can be removed by the McBurney transduodenal choledochotomy. When lodged in the first or second portions of the common duct, direct incision of the duct must be chosen in preference to manipulation and attempted dislodgment of the stone. If the stone is impacted in the pancreatic portion of the duct it can be approached by mobilizing the duodenum, displacing it inward, and separating the loose connective tissue posterior to the head of the pancreas and lifting the latter forward. The discovery of one stone impacted in the duct does not preclude the presence of others, either in the ducts, the ampulla, or the gall-bladder, and most thorough exploration of the entire gall tract must be made in every instance.

Subsequent drainage of the biliary tract is essential to success. Whether this drainage is to be temporary or permanent will depend upon the degree of infection in the bile and pancreatic channels and the severity of the pancreatitis, as evidenced by the amount of swelling of the head of the pancreas and the degree of common-duct obstruction produced thereby. When the infection in the ducts is mild, when the swelling of the head of the pancreas is but slight, and when gall-stones are present, temporary drainage is indicated. This may be obtained by drainage of the gall-bladder by a cholecystostomy, or, when either the supraduodenal or the retroduodenal portions of the common duct have been incised for the removal of a calculus, by direct drainage of the duct by means of a rubber drainage tube carried into the duct and directed toward the liver.

In the majority of instances, however, especially when no calculi are found in any portion of the biliary tract, because of the uncertain length of time during which temporary drainage may persist, and because of the chronically persistent changes in the pancreas—changes which may not disappear and which are obstructive in their nature—permanent rather than temporary drainage must be provided. This is accomplished by the performance of a cholecystenterostomy or, more correctly speaking, a cholecystoduodenostomy, for the duodenum, rather than a lower portion of the bowel, should, whenever possible, be selected for the site of anastomosis. By anastomosing the gall-bladder with the duodenum the bile continues to be poured into the intestinal tract close to the outlet of the stomach, where the escaping stomach contents are early mixed therewith, as is nature's intention and provision. Of great subsequent importance is the fact that the danger of retrograde infection of the gall-bladder and ducts from the intestine is reduced to the minimum by selecting the duodenum as the site for anastomosis.

In the performance of any and of all of these operations the fact that the bile tract and its contents are highly infectious must never be forgotten. The peritoneal cavity must

be especially well walled off by means of gauze pads. Before incising the gall-bladder it should be isolated from the surrounding structures by rubber tissue, as a dentist isolates a tooth. Abundant drainage will frequently be called for and can be assured by the employment of a split tube or tubes.

In conclusion, I would submit: That pancreatitis is of far more frequent occurrence than has been believed in the past; that it is a disease progressive in its nature and tending to a fatal termination; that it can, with the present methods at our command, be diagnosed without difficulty; that it is in the great majority of instances, secondary to, and dependent upon, cholelithiasis or infection of the biliary tract; that it can be cured, or its progress stayed, by the early removal of its causes and the prevention of their recurrence; that, its presence having been demonstrated, the immediate removal of its cause is imperative; that sodium phosphate, olive oil, neglect, delay, and optimistic indifference in the treatment of gallstones must give way to prompt, radical, and efficient surgical intervention.

THE ADVANTAGE OF SIMPLICITY IN OPERATIONS FOR APPENDICITIS.

A REPORT BASED ON 110 CONSECUTIVE OPERATIONS WITHOUT MORTALITY.*

BY CHARLES N. DOWD, M.D.,

OF NEW YORK,

Attending Surgeon to the General Memorial Hospital and St. Mary's Free Hospital for Children; Adjunct Professsor of Clinical Surgery in Columbia University.

Not many years ago the current teaching indicated that a "surgical procedure" was one which was done under the guidance of the eye, any operation not so done being characterized as "unsurgical." Since large wounds "heal as quickly as small ones," it was believed that the best results were to be obtained by making extensive dissections and inspecting the field of operation at each stage of its progress. This teaching, although sound in general principle, has been much modified: the appreciation of cleavage layers often obviates the necessity of extensive dissections, and patients have really been found to do best when the surgical procedure is thoroughly accomplished, with the minimum of tissue disturbance.

The surgical treatment of appendicitis was developed on the basis of the older teaching; it was believed that large incisions should be made, that the intestines should be walled back by gauze pads, that the entire appendical area should be inspected, that all possible local evidences of inflammation should be removed, and that the adjoining parts of the intestinal peritoneum should be treated with more or less vigor. The procedures have been simplified in general surgical practice so that the average appendicitis operation of to-day probably represents less than one-quarter the tissue disturbance which it did fifteen years ago. It would be difficult to

* Presented before the New York Surgical Society, May 12, 1909.

enumerate the authors who have helped to effect this change, but Dr. Robert T. Morris of this city was surely a pioneer, and Drs. Hotchkiss, Stimson and Lilienthal have made contributions of very great value, while Drs. Murphy and Ochsner of Chicago, and the Drs. Mayo of Rochester, Minn., have emphasized and developed the details of the principle with the vast wealth of material at their disposal. In the very extensive literature which bears on the subject one can find an increasing tendency to trust the peritoneum to care for the moderate grades of inflammation which are at a distance from the appendix, and to relieve the local appendical inflammation in the simplest possible way.

Since, however, there are still many surgeons who adhere more or less to the older method, the writer ventures to add another small contribution to the subject in recording the last 110 cases which have been operated upon in his service in the General Memorial Hospital, in St. Mary's Free Hospital for Children and in private practice. The series includes all the operations for appendicitis since September, 1907.

The tabulation was done by Dr. Charles E. Farr. Eighty-eight of the operations were done by the writer, seven by his associate, Dr. Mathews, and fifteen by other members of the assistant or house staff under the writer's personal supervision.

Patients are not included from whom practically normal appendices were removed in the course of operation for other conditions. In one sense, the series was a selected one; in another sense not. Owing to the character of the St. Mary's Hospital service, forty-four of the patients were under fifteen years of age. Owing to the character of the General Memorial Hospital service, patients were not sent there in the last stages of general peritonitis, as frequently happens in the larger general hospitals. Operation, however, in either of the hospitals or in private practice, was not refused to any applicant who had appendicitis. The series represents the cases as they came, without personal selection. There was no mortality among them; they all left the hospital or their sick beds in apparently good condition; their wounds were either com-

pletely healed at the time of discharge or were so healed soon afterward.

(June 21: Ten more cases have been operated upon without mortality, one too recently for prognosis, the others either in good health or in various stages of satisfactory convalescence. A patient who had left the hospital with her wound healed, and had enjoyed good health for three weeks after reaching home, developed febrile symptoms, without any symptoms of abdominal disease, and died—of pulmonary disease, the attending physician believes. This case is not counted as an operative mortality since both attending and consulting physicians have stated definitely that the symptoms were not abdominal but were pulmonary. She is referred to, however, as it is the writer's wish to represent the series exactly as it is.)

This freedom from mortality is not referred to as remarkable; many operators have had long series of similarly good results. The credit is largely due to the physicians who now so generally send the patients to the hospital before general peritonitis has been established.

The tables show that 24 cases were operated upon in the "interval," and that 22 were classed as chronic cases, having appendical constrictions, adhesions or other abnormalities which caused persistent symptoms. In the remaining 64 more acute cases the duration of time between the onset of symptoms and the operation has been tabulated as follows:

Operation in the first day	12 cases
Operation in the second day	16 cases
Operation in the third day	16 cases
Operation in the fourth day	2 cases
Operation in the fifth day	1 case
Operation in the sixth day	1 case
Operation in the seventh day	4 cases
Operation in the eighth day	5 cases
Operation in the tenth day	2 cases
Operation in the eleventh day	1 case
Operation in the twelfth day	3 cases
Operation in the twenty-third day	1 case

These patients were purulent in greater or less degree, some of them to a very great degree. It is particularly in

their group that differences in surgical procedure exist and are important.

The method which has been used for them has been (1) removal of the appendix (if it could be easily reached) by the simplest available method; (2) drainage of the appendical site if pus was there; (3) neglect of the rest of the peritoneal cavity (excepting as the previously mentioned drainage opening provided an exit for its seropus during the first few hours after operation).

1. Under the first of these headings the following details of technic may be referred to: McBurney's incision placed well toward the side, so as to avoid unnecessary contact with the small intestine; size of incision, as small as will furnish satisfactory access to the appendical site, thus avoiding the intestinal exposure which so often accompanies large incisions; avoidance of pads, as far as possible, and use of broad retractors for holding back the intestines; following of longitudinal cæcal bands by aid of plain thumb forceps if appendix is not otherwise reached; separation of appendix from its bed of adhesions by fingers, often out of sight, sometimes aided by traction of aneurism needle passed through base of mesenteriolum; grasp of mesenteriolum by Ferguson clamp when possible, thus facilitating movement of, and access to, the cæcal end. The retractors can then usually be released and the appendix removed and its stump ligated and suitably treated within the walls of the incision and well away from the remainder of the peritoneum.

2. *Drainage.*—In providing for drainage of the appendical site, disturbance of the exudate which lines the abscess wall is avoided, the pus is simply taken up by gauze as it exudes. Soft rubber tubes, or gauze protected by rubber dam, are inserted and secured in position and a portion of the wound closed. Absorbent moist gauze dressings are changed twice daily for the first two days, then less frequently.

3. *General Peritoneum.*—The treatment of that portion of the peritoneum which is at a distance from the appendical site and certain other details may be best considered in referring to illustrative cases.

CASE I.—*Localized abscess; much seropus in general abdominal cavity. Abscess drained; general abdomen disregarded.* C. S., æt. 13, admitted to hospital three days after the onset of a severe attack of acute appendicitis. Temperature, 104°; pulse, 120; looked very ill and had much abdominal rigidity and a palpable mass in appendical region. Leucocyte count, 24,000; polynuclear, 90 per cent.

Incision was made well to the side and the opening of the peritoneum was followed by a gush of seropus. An abscess cavity was found in the cæcal region, which contained a ruptured appendix, concretions and thick foul-smelling pus. The appendix was enucleated from a mass of adhesions by the finger; its stump was ligated with catgut; gauze, protected by rubber tissue, was placed against it as a drain. A moist dressing was applied and she was returned to the ward without further procedure. Semi-erect posture and continuous saline rectal irrigation were used. Food was withheld for thirty-six hours, when a little broth was given. There was an abundant discharge of pus into the dressing and the wound was not entirely healed until five weeks later, but otherwise recovery was uneventful.

This represents a class of cases which has caused much confusion in the consideration of the subject, this confusion depending largely on the interpretation of the seropus (or cloudy serum) which lies free in the peritoneal cavity, and which gushes from the incision when the peritoneum is opened; it is usually almost white. Those who consider it highly infectious pus believe the case to be one of diffuse or general peritonitis, and they will surely find the intestines to be red if they handle them much. Those who believe that this seropus has very slight infective power will disregard it; they are accustomed to see serous effusions after various irritations, *e. g.*, strangulated hernia, early unruptured appendicitis; and know that it can contain many leucocytes without having much infective power, and they know that in cases with old encapsulated appendical abscesses it has largely disappeared. In this particular case, and in others which I have had examined, no culture grew from it. In this series of cases this seropus has been regularly disregarded, although it has often been present in large amount. General peri-

tonitis has not followed in a single instance, and there has been only one secondary abscess to open.

The local abscess about the appendix is of course different. The pus here is usually highly infective, and every effort should be made to protect the general peritoneal cavity from its virulence.

The following case is also illustrative:

CASE II.—*Very long gangrenous appendix lying in middle of abdomen, with no apparent encapsulation. Profound sepsis; appendical tract drained; general abdomen disregarded.* C. S., æt. 51, admitted to General Memorial Hospital after two days of suffering from a very severe attack of gangrenous appendicitis, with severe pain, vomiting, chill and extreme prostration.

On operation the appendix was found to be six inches long, gangrenous throughout its entire length and containing four concretions; its tip lay to the left of the median line. In the patient's critical condition, the manipulation and cutting necessary to gain a complete exposure would surely have been fatal. On following the appendix with the finger, however, it was found to loosen, and was thus enucleated. Before the fingers were removed from the long tract where it had lain, cigarette drains were inserted to its end. The appendix was then removed after its base had been compressed and ligated and the stump cauterized and buried under a purse-string suture. No other treatment was given excepting the postoperative measures already referred to, and the recovery was prompt and uneventful.

There have been many of the severe cases similar to these two, and the prompt way in which they recovered when the appendix was treated in a very simple way, and the rest of the peritoneal cavity was disregarded, has made the writer very confident of the advantage of the method. The results have certainly been very much better than they were under the methods previously used.

The question of *appendix removal* is often an important one. The cases from whom it is not removed at the primary operation are illustrated by the following:

CASE III.—*Appendicitis of twelve days' duration; extensive peritonitis; much pus. Appendix not removed at primary opera-*

tion. E. H., a well-nourished child of 6 years, was brought to St. Mary's Hospital, February 27, 1908. Twelve days previously she had begun to have abdominal pain and to vomit. The vomiting had persisted and for the last few days she had been extremely ill, having much abdominal distention. On admission she presented the picture of extreme depression, with sordes on teeth, abdominal distention, rigidity and tenderness. Pulse, 120; temperature, 103°. Leucocytes, 68,000, 90 per cent. polynuclear.

Incision over the appendical region was made without delay. Much pus escaped. Such intestines as were seen were red, and there was much deposit of fibrin. No distinct abscess wall was evident. The examining finger could detect openings apparently to other parts of the abdomen. The appendix was not evident and no extended effort was made to find it. Her only chance of recovery manifestly lay in taking advantage of such adhesions as had already formed and relieving the site of maximum inflammation. Therefore, soft rubber tubes were simply put through the opening and a voluminous dressing applied. The operative procedure occupied hardly more than five minutes. She was returned to the ward and put in the Fowler position. Saline rectal irrigation was used. The dressings were changed twice daily at first. Food was withheld for twenty-four hours. Then, since she would not take broth, peptonized milk (half ounce, q. 2 h.) was given. During the process of healing sloughs or fibrinous coagula came through the wound, but she made a good recovery, excepting for a hernia, which was repaired in July, when the appendix was also removed.

There have been three cases in the series from whom the appendix was not removed. In work which preceded this series the writer has left it in several times and has had to remove it later in about one-third of the cases.

While considering the subject of protracted search for the appendix, the history of one of the patients of this group may be narrated. She had had a previous operation less than three years ago on the basis of the older teaching. The operation was done in a very good hospital, by an unusually good surgeon; the history was brought to me by the attending physician, and since location hides the identity of both hospital and surgeon, it is given in detail to show how radically a

method of procedure, which was recently in general use and which is still in limited use, differs from the one here advocated.

The usual intermuscular incision, three inches long, was made through the abdominal wall, over the appendix, and the peritoneum opened. The cæcum was found presenting. To this the lower portion of the omentum was adherent, and the whole was bound tightly down with firm adhesions. These were broken up below and beneath the cæcum. A large abscess cavity, well walled off with firm adhesions and filled with thin, yellowish pus with foul odor, was found. The rest of the abdominal cavity having been previously walled off with pads, the pus was washed out with saline and the cavity sponged out. All the bleeding points were clamped and ligated and the contents of the abscess cavity examined. It was impossible to definitely identify the appendix, but a large necrotic and inflammatory mass, about the size of a large hen's egg and believed to contain the organ, was ligated and cut away. The lower portion of the omentum was likewise cut away and a drainage tube of rolled rubber dam was inserted down to the bottom of the abscess cavity. A split rubber tube with gauze wick was placed down to the iliac fossa and two accessory drains of gauze were placed beneath the cæcum. The wound was partially closed.

After the operation intravenous injection of salt solution was given and the temperature ranged around 103° until July 14, one week after the operation, when it touched normal. July 20, again arose to 103° and did not subside until July 25. July 31 a chill and temperature 103° once more, and at least twice the abdomen was searched for pus pockets. One pocket of pus in upper part of incision was found. Warm applications were applied q. 3 h. for several successive days at different periods. Temperature finally remained normal on August 8, and on the eighteenth the patient came home, the wound healing by granulation.

If the abscess had simply been opened and drained the extreme depression which made infusion necessary would certainly have been avoided. The extensive breaking up of adhesions, the use of fluid in the abscess cavity, the extensive exposure and wiping and the dissecting out of the egg-sized mass, were severe traumatisms and infection-spreading procedures. It is easy to believe that they were the cause of the extreme illness and the stormy and prolonged convalescence which followed. Furthermore, they accomplished no good purpose, as the appendix was left in after all and had to be removed at a subsequent operation. It is difficult to appreciate how a low mortality rate can follow this type of procedure.

AN IRRIGATING SOUND OF THE STANDARD AND BENIQUÉ TYPE.

ALSO AN IRRIGATING TUNNELLED AND GROOVED SOUND FOR THE DILATATION TREATMENT OF STRICTURE OF THE MALE URETHRA.*

BY VICTOR COX PEDERSEN, M.D.

OF NEW YORK.

Genito-urinary Surgeon of the Outpatient Department of the New York Hospital and House of Relief (Hudson Street Hospital).

UNTOWARD results following the passage of sounds through the male urethra into the bladder are not by any means uncommon, even when there is neither stricture nor deformity of the passage, nor discoverable infection present. The uncertain manner in which the gonococcus lurks in the deep urethra, even after subjective and objective symptoms have disappeared, makes the danger of infecting the bladder the greatest of these unfavorable sequelæ. In a certain number of cases reflex nervous symptoms reaching even the limit of temporary anuria and of more or less severe urethral fever have been reported.

The writer has always had the feeling that the one surely safe procedure lies in filling the bladder with a warm mild antiseptic solution immediately after withdrawing the sound, which will provide against infection of the bladder, as previously stated, and will, by permitting the patient to evacuate this quantity of fluid, tend to correct the dangers of anuria and nervous chill. The antiseptic will furthermore protect against septic urethral fever.

For these reasons during many years the habit of the writer has been to follow the sound with a soft rubber or woven silk catheter by means of which the irrigation of the urethra and the bladder is accomplished. In addition to this, another detail of treatment has in the majority of cases been carried out, namely, to give sthenic patients morphine gr. 1/8–1/4, fluid-

* Read before the American Urological Association, June 7, 1909.

extract of aconite mimims 2–3, and sulphate of quinine gr. 5–10. For asthenic individuals the medication is changed to codein gr. ½–1, nitroglycerin gr. $^1/_{100}$–$^1/_{50}$, quinine gr. 5–10. These are not "gunshot mixtures," far otherwise: the morphine or the codein allays nervous excitement; the aconite or the nitroglycerin dilates the blood-vessels, thus correcting congestion; and the quinine is an efficient febrifuge. After long experience with these combinations, the writer has still to find anything better for the purposes.

The passing of the catheter, however, has the objection of doubling the instrumentation, which is a decided disadvantage on account of the dangers of infection primarily and secondarily on account of the nervous irritation of the patient in cases, for example, where the sphincter of the bladder passes into slight spasm after withdrawal of the sound. In order to correct these features the writer devised an irrigating sound based primarily on the fact that in order to be readily aseptic the tube in the sound must be perfectly straight and have only end openings, so that a swab might be passed through it easily, if necessary.

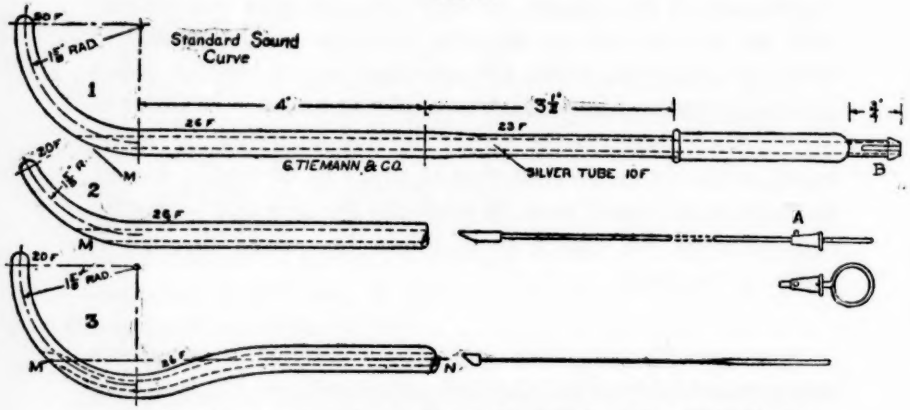
After considerable study and experimentation, a sound has been produced (see Fig. 1) which corresponds to the following description from No. 18 F. upward.

The irrigating tube is a silver catheter and is of the same size for the entire series, namely, 10 F. It runs straight through the shaft of the sound from the base of the curve to the nipple at the handle, at which it receives the rubber tube from the irrigator. At first sight this point of emergence at the base of the curve may seem to be incorrect, but actual practice with the sound shows that the necks of most bladders seize the sound just in front of the opening so that the irrigating fluid is delivered exactly where it is most required, namely, upon the floor of the bladder. In a few bladders it is necessary to push the sound in a little further, or to rotate its tip to the right or the left in order to disengage the opening of the tube from the mucous membrane, or to depress the handle of the sound in order to elevate the opening above the bladder floor.

The diameter of the silver catheter, 10 F., is amply large for evacuation of thick contents of the bladder and for irrigation of that viscus with due and normal rapidity.

As to the advantage of delivering the irrigation just within the neck of the bladder and directly upon the bladder floor, attention of the reader is drawn to the double-current irrigating instrument devised by Peterkin,[1] exhibited before the American Urological Association and described in the Transactions of that body, 1909. The instrument consists of the sheath of a cystoscope through which a tightly fitting partition is carried, borne upon a water-tight plug which fits the outer end of the

FIG. 1.



From above downward are shown the sounds with standard, shortened and Beniqué tips. The 6-size taper from straight shaft to point (26–20 F.) is indicated, also the 3-size reduction of Chetwood near the handle (26–23 F.) *M* points to the bladder outlet of the silver tube (10 F. diameter) and *B* to the hose-connection, identical for all sizes of the set. In the Beniqué instrument *M* shows the straight projection forward of the tube to open in the curve at a point just above the bladder floor. *A* illustrates the obturator. Note the position of the little plug far down the handle of *A*, to agree with the long slot in *B*; if the obturator is not properly seated in *B* the plug will not show at *M*, thus avoiding the accident of having the sharp point of the obturator project against the urethra and bladder, because this point is shorter than the slot in *B*.

sheath and itself carries one tube each into both halves of the sheath thus set off by the partition, and thus permitting inflow and outflow after the double-current method.

The nipple is also of uniform size for the entire set and is

tipped with a cone-shaped collar for rubber tubing ⅜ inch in diameter. This uniformity saves a great deal of trouble in making the connections, as this size of rubber tube is that commonly employed on irrigators and hand syringes.

The handle of the sounds is of the shell-like variety commonly seen on many instruments, and does not vary from sound to sound.

The shaft is of the double taper type introduced by Dr. Chetwood.[2] The first 3½ inches next to the handle are three sizes smaller than the main shaft, which then passes forward at full size for 4 inches until the base of the curve is reached, thus making the straight part of the shaft 7½ inches long.

The curve of the sound is on a radius of 1⅝ inches, which is the curve of the nonirrigating standard sound. The length of the curve is a trifle more than 90°, which is also the length of the curve of the nonirrigating standard sound. The taper of the curve is uniformly 6 sizes from the base to the tip, so that, for example, size 26 F. is 20 F. at the beak. In the writer's experience this taper is the most convenient. Some authorities prefer the standard curve but shorten it by about one inch.

Many other authorities prefer the Beniqué curve sound. In case sounds with the Beniqué tipe are to be used, I would suggest that the first 90 degrees of the instrument be tapered 6 sizes, so that, for example, a No. 26 F. instrument is 20 F. at the point. The tunnel should also pass along the curve until it emerges at a point corresponding with a straight line projected through the straight part of the shaft of the instrument until it cuts the curve. Thus a point of emergence is reached which will be just above the bladder floor when the sound is inserted exactly as in the other two forms. Although in the Beniqué sound the tunnel is no longer literally straight, in having only end-openings it may readily be cleansed. The obturator is of the same form as that just described excepting that the first few inches of the shaft are flexible, by being made of flat spring-metal.

The obturator of the sound consists of a small plug ground to fit the opening at the base of the curve of the sound accurately, mounted on a long rigid wire with a loop handle at the other end. A little metal plug fits into the lumen of the nipple, thus steadying the obturator at this point. In order to prevent the obturator

from twisting, a device like a simplified bayonet-catch has been provided between the nipple and the handle of the obturator.

In order to prevent the sharp corner of the obturator seen in *A*, Fig. 1 (made by the obliquity of one surface where it matches the curve of the instrument), from projecting out of the silver tube and thus cutting the patient if it were to be placed in the inverted position in the tube of the instrument, the slot of the bayonet-catch in the nipple has been made very long and the plug on the handle of the obturator has been set forward a corresponding distance. Thus if the obturator is wrongly inserted the plug will prevent the obturator from being seated home at all until it is rotated so that the peg is in the slot.

When the obturator is set, in order to prevent any sharp edges whatsoever, the surface of the obturator has been *convexed* a little and the opening in the silver tube *concaved* a little, thereby preventing sharp edges.

These irrigating standard sounds have been in use by the writer and his colleague, Dr. Walter B. Brouner, for two years, having been devised in 1907.* The Beniqué and standard forms were shown before the Genito-urinary Section of the New York Academy of Medicine at its meeting in December, 1907.

The manner of using the sounds is as follows: After thoroughly boiling, the obturator is examined to see that it is freely movable for final withdrawal and then it is pushed into proper position and locked. The sound is then lubricated and introduced into the urethra in the usual manner. It is well to place the little finger through the loop in the handle of the obturator so as to be sure that the obturator does not slip. For the same reason it is also well to make the final pressure upon the sound by means of the obturator-handle, which is stout enough to permit thereof. After the sound has remained in place the desired five or ten minutes the obturator

* The dates for the mechanical drawings for these sounds are as follows: irrigating sound, Beniqué curve, March 15, 1907; irrigating sound, standard curve, March 29, 1907; irrigating sound, short curve, December 21, 1907. The drawing for the tunnelled and grooved sound (subsequently described in this monograph) is dated January 27, 1908. This chronology may be of historical value later.

is gently withdrawn. Sometimes a flow of urine follows, especially if the sound has been left in the bladder five minutes or more. A receptacle should therefore be at hand to catch such evacuation.

The irrigator, having previously been filled with the desired warm antiseptic fluid, is now connected to the nipple. The act of attaching the rubber tubing for the irrigator or syringe should be done so gently that chafing or scraping the bladder

FIG. 2.

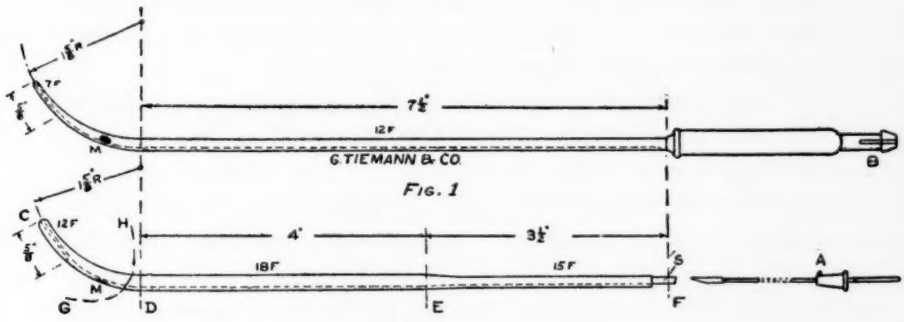


FIG. 2

N°s 7.8.9.10.11.12 are made of steel tubing, nickel plated opening on side in order to clear the groove (M, Fig. 1)
N°s 13.14.15.16.17.18.19.20, open on the convexity of the curve (M, Fig. 2)
N°s 8.9.10.11.12 taper to 7 at the end, in Nos 13.14.15 16 17 the taper is six numbers, uniformly (Fig. 1)
Only N° 18 and larger are double tapered In a N° 'N' sound the curved portion i.e between C and D would increase from 'N-6' at C to 'N' at D, the portion between D and E is of uniform circumference 'N'; and the portion between E and F is also of uniform circumference but smaller i.e 'N-3' (Fig. 2)
In all sizes the diameter of tunnel and groove, the handle, and the rubber hose fitting are the same
N° 13 and larger have a silver tube (S) which is the same in all sizes, 7 Fr (Fig. 2)
All the above numbers refer to the French scale

floor with the open end of the channel in the sound should not occur. In the writer's experience it is best for this purpose to have a three-inch piece of rubber tube of such size as to slip over the nipple very readily, but water-tight. Into this the conical tip of the syringe or irrigator may be slipped without disturbing the sound. Although apparently simple this is a very important detail.

Under gentle pressure a few ounces of fluid at a time are run into and out of the bladder. If the flow does not immediately start it is probably due to the fact that the mucous membrane of the bladder floor lies too tightly against the

bladder end of the tunnel. Rotation of the sound to right or left will correct this little difficulty. Or, the obstruction may be due to the fact that the sound is not in the bladder quite far enough, which is corrected by pushing it gently onward. If this is suspected, it is better to reintroduce the obturator because the oblique opening of the silver tube at the base of the curve makes the progress of the sound painful in these circumstances. After the bladder has been irrigated it is finally filled with the fluid and the sound without the obturator is withdrawn. The patient is then allowed to evacuate the antiseptic at once or to carry it away with him in his bladder for evacuation a quarter-hour or a half-hour later.

The results of using this sound seem to be emphatically not only a protection against all ordinary dangers of sound passing, but a distinct promotion of the comfort and reassurance to the patient. The writer has had, for example, a number of very intelligent patients who, although from the hands of well-known physicians, have stated that they never have felt so comfortable after the passing of a sound as they do after these irrigations and evacuations of a warm simple antiseptic fluid.

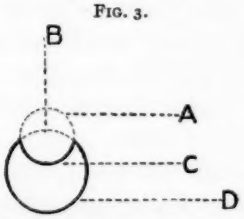
II. AN IRRIGATING TUNNELLED AND GROOVED SOUND FOR THE DILATATION TREATMENT OF STRICTURE OF THE MALE URETHRA.

Without entering into a lengthy discussion of the comparative merits in the treatment of stricture of the male urethra between the methods of dilatation and of internal and external urethrotomy, it is reasonably accurate to say that in the absence of inflammation of the urethra, bladder, and kidneys, which would indicate drainage, dilatation may be applied to most strictures of moderate extent along the length of the urethra through which a filiform guide may be passed. The tendency is to advocate the use of soft instruments in the early stages of dilatation until the halfway point (say 15 F.) has been reached. For the average practitioner this is certainly the safest rule; for the expert, however, who is

always willing to be patient, gentle, and deliberate, rigid instruments are perfectly safe, provided that step by step (say every quarter-inch of advance) the freedom of the filiform guide in the tunnel is always proved by drawing out or pushing in the filiform a little. Many strictures which might require operation, thus taking the patient away from business, may be successfully dilated.

The necessity of always washing out the bladder and urethra after any instrumentation led the writer to devise an irrigating tunnelled and grooved sound laid down on the lines of the original Van Buren-Gouley sound. Hitherto the only

FIG. 3.



The dotted semicircle *A* indicates the waste of the small tube used to make the groove of the sound. The dark semicircle *C* shows the portion thereof comprising the groove. The dotted line *B* shows the waste of the larger tube cut away to accommodate *C*. The heavy line *D* represents the portion, which brazed together with *C*, makes up the cross-section of the sound.

irrigating instrument which might be used as a sound is the silver catheter, which unfortunately is so soft as to defeat its own purpose in no small number of cases. The writer has devised a tunnelled and grooved sound by taking two steel tubes for the small sizes and by cutting a segment out of the wall of each which when brazed together give the shaft of the sound, *D*, and the groove of the sound, *C* (see Fig. 3).

The smallest size of the series is 7 F. These sizes are taken on the ground that if a stricture will not accept size 7 F. easily it had best be subjected to external urethrotomy, and on the ground that if the stricture accepts sound 7 F. it may be dilated to 8, 9, or 10 F. at the first sitting. It is to be remembered that the guide of the Maissonneuve urethrotome is 7 F. in diameter. This fact led the writer to determine upon the same size as the extreme small limit for the tips of his series of sounds.

In order to preserve the plan of the irrigating standard sounds just described, the curvature is uniformly of 1⅝ inches radius,

the length of the curve is approximately 1 inch shorter than that of the standard sound. To compensate for this shortening of the tip the straight part of the shaft is elongated 1 inch. The taper of the curve is uniformly six French numbers in all sizes from 13 to 20. Sizes 8 to 12, both inclusive, however, taper to No. 7 at the point. By this plan of six-size taper where possible the dilatation is made very gradual. For example, size 18 F. is at the tip 12 F., at the middle of the curve 15 F., and at thirds of the distance between the tip and the middle of the curve 13 and 14 F., respectively, and at thirds of the distance between the midpoint and the straight shaft 16 and 17 F. respectively. Also, for example, size 10 F. is 7 F. at the tip and 8½ F. at the midpoint, and so on for the whole series of sounds. This careful uniformity of taper is of great service in using the sounds, for a stricture which has taken 8 F. will accept almost the half-beak of the 10 F. instrument before the real dilation begins, and a stricture which has taken 16 F. will engage almost two-thirds of the beak of an 18 F. sound before stretching ensues. Thus far greater safety in the use of the instruments is gained.

It is not necessary to have an office set consisting of all sizes. The author has found the even numbers sufficient, namely, 8 to 26 F., inclusive. Ordinarily No. 20 F. would be the largest required. Two patients, however, who refused urethrotomy had dense extensive strictures which required for safety the other numbers of the series stated, namely: 22, 24, and 26 F.

The shafts of the instrument are of uniform size from the base of the curve to the handle until size 18 F. and larger are reached. Then the double-taper plan of Chetwood is used.

The tunnels of the tips are of uniform diameter from the smallest to the largest sounds, namely, a trifle over the diameter of the ordinary whalebone filiform guide. This plan prevents wabbling of the larger sizes upon the filiform and accustoms the operator to a *uniform feel* of the action of the sounds in passing along the guides, also a very important detail. All tunnels are moreover ⅝ inch long, which gives relatively extensive cones for the tips of the sounds. The long-tunnelled tip follows the direction of the filiform better and really prevents the tendency of short tunnels to cut or buckle the filiform.

The grooves begin at the proximal ends of the tunnels and extend throughout the shaft to the handle and are likewise of

uniform width and depth, *i.e.*, large enough to accommodate the standard filiform guide. This excess of space between the filiforms and the grooves is ample for the purposes of urethrotomy, namely, of guiding the knife and the director, should such be necessary.

Irrigation is provided for in sounds No. 13 F. and larger by silver catheters of uniform size (7 F.) extending from the base of the curve of the tip to the rubber hose-fitting in the handle and opening into the groove at the base of the curve. Sizes 7 to 12 (both inclusive) are hollow throughout and in order to clear the groove have the opening on the side also at the base of the curve. This is necessary because a separate silver tube could not be incorporated into such small sizes.

The handles of the sounds, including the hose-connections and the obturators of the sounds, are the duplicates of the types used in the standard sounds described in the first part of the article.

The extreme advantage of this type of irrigating tunnelled and grooved sound lies in the fact that it permits treatment of the bladder through the one and same instrument as is used to dilate the stricture. In other words, instrumentation is halved, *i.e.*, reduced to a minimum, which in most strictures is of extreme importance, because the reflexes due to irritation are matters of moment in all stricture-instrumentation.

In closing this paper it seems well to add a few paragraphs for description of similar sounds which have preceded those of the author. The following historical review, therefore, of dilating and irrigating sounds seems warranted.

Syme's [3] guide appears to have been one of the earliest instruments for passing through stricture. It had no tunnel, but a long small curve shaped like an ordinary sound. The curve and first portion of the shaft were reduced to a small diameter and ended in a shoulder, whence proceeded a straight shaft to the handle. The shaft and tip were grooved as the guide to knife when operating. The tip, however, was so small that doubtless frequent accidents happened, due to the fact that the sharp point had no whalebone guide to make it clear the urethral walls.

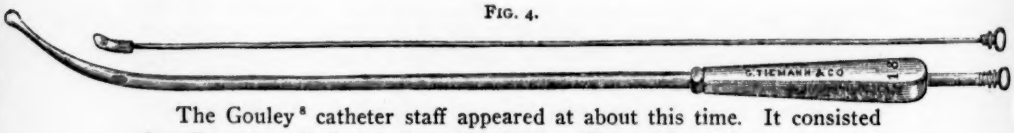
G. Frank Lydston [4] says: "The late Professor W. H. Van Buren was the inventor of the first tunnelled instruments ever used and should have due credit for them." Gouley, however, seems to have been the first to

describe the same. According to Van Buren and Keyes,[5] Gouley borrowed his idea from Van Buren. Without entering into a controversy long since passed, it will probably be good judgment to give both men credit and call the first type of tunneled instruments used the Van Buren-Gouley tunnelled and grooved sound, which was described by Gouley[6] in 1864. The original description reads: "It is a grooved conical steel sound with a canal one-eighth of an inch in length at the vesical extremity, and with a curve equal to one-fifth the circumference of a circle three and a quarter inches in diameter. The smallest (No. 3) is one and a half millimetres in diameter at the point. I have had larger ones (to No. 15) made to fully dilate strictures complicated with false passages, and have named them tunnelled sounds. When a capillary whalebone guide has passed through a tortuous or an eccentric stricture and has entered the bladder, the free end is slipped through the tunnel of the smallest sound, which is carried down to the obstacle, held in firm contact with it,—precaution being taken to keep the guide in the groove of the staff,—and in a few moments the instrument will pass, but no force or undue pressure should be used. It is desirable after having accomplished this much, to carry on dilatation rapidly, at the same sitting, to four or five higher numbers, to guard against the possibility of retention of urine from too great inflammatory swelling. The stricture should then be treated by gradual dilatation, and no other method thought of, unless dilatation fails after a thorough trial."

One feature of difference between the Van Buren-Gouley tunnelled instruments and those of the writer is that in the former the tunnels increase in diameter with the increase in the size of the sounds. In the opinion of the writer this is a mistake, because it deprives the operator of a uniform "feel" as to how the instrument is sliding over the filiform, duly provided for in the sounds of the writer by having all the tunnels of the same diameter and length.

Gouley's[7] catheter appeared about 1869 and is thus described: "In 1869 I adapted the tunnelled principle to the one-eyed English gum catheters and have used them with much satisfaction and success. The whalebone guide is passed through the vesical extremity of the instrument, which is open, and out of the eye. Their use is especially indicated when, after having made rapid dilatation of a narrow stricture, it is found necessary to retain a catheter for a few hours."

FIG. 4.



The Gouley[8] catheter staff appeared at about this time. It consisted of a silver tunnelled and grooved catheter with an obturator.

F. N. Otis's[9] dilating catheter was threaded from an opening in the end of the tube to the handle throughout the instrument.

L. B. Bangs's[10] instillating catheter sound was the next advance. It modified the Keys-Ultzmann syringe-sound so as to make the tips attach to the syringe-barrel by a slip-joint. Thus a set of tips comprising any series of sizes could be used. Through a small central tube from handle to tip irrigation of the bladder may be accomplished. The tube, however,

is too small to permit the evacuation of thick bladder contents. The range of tips, however, in the set permits dilatation of the stricture and instillation of healing solutions upon the damaged mucous membrane to be practised with the greatest possible advantage.

About twelve years ago Dr. Willy Meyer [11] exhibited before the New York Academy of Medicine a sound reaching the indications for irrigation of the bladder and devised by Trendelenburg, of which the above is an illustration. It will be noted, however, that the Trendelenburg sound has an olivary tip, a peculiar, open, short curve, and lateral openings, thus, excepting in its purpose, it differs materially from the writer's sound.

This paper cannot be closed without giving credit to C. E. Panoff, M.D., for a sound described in the *New York Medical Journal* of June 12, 1909, in general terms closely like the sounds of the writer. Dr. Panoff states that the dates of the various models are July 23, 1908, Jan. 3, 1909, and May 17, 1909. It will thus be seen that the sounds of the writer were designed and in use more than a year previous to Panoff's.

In Panoff's sound the channel for irrigation is not a silver catheter and does not run through in a straight line to the base of the curve of the tip. The opening of the channel is inferiorly placed about three-quarters of an inch back from the base of the curve, thus requiring a deeper introduction into the bladder than do the sounds of the writer. The experience of Panoff, however, is identical with those who have used the sounds, namely, that the act of voiding artificial urine after instrumentation adds to the comfort of the patient. It is very interesting to see how two persons, unacquainted one with the other, working in the same specialty, should have reached much the same design of instrument independently one of the other.

REFERENCES.

[1] Peterkin: Transactions American Urological Association, 1909.

[2] Chetwood and Keyes: Venereal Diseases, 1900, p. 126.

[3] Truax, Charles: Mechanics of Surgery, 1899, p. 594.

[4] Bangs and Hardaway: An American Text-book of Genito-urinary Diseases and Syphilis and Diseases of the Skin, 1899, p. 176. G. Frank Lydston, "Organic Stricture."

[5] Van Buren and Keyes: Genito-urinary Diseases with Syphilis, 1874. Footnotes, pp. 127–129 (both inclusive).

[6] Gouley: Diseases of the Urinary Organs, 1873, p. 53.

[7] *Opus cit.*, p. 54.

[8] *Opus cit.*, p. 124.

[9] Otis, F. N.: Pamphlet 4741, N. Y. Academy of Medicine, p. 15. A Description of the Instruments and Apparatus of the Author with Directions for their use in Operations on the Genito-urinary Organs.

[10] Bangs and Hardaway: *Opus cit.*, 1899, p. 598. James Pedersen, "Impotence."

[11] Meyer, Willy: Roser's Sound and Trendelenburg's Catheter-Sound, N. Y. Medical Journal, 1892, vol. lvi, p. 162–163.

INTRAVENOUS LOCAL ANÆSTHESIA.

BY JAMES MORLEY HITZROT, M.D.,

OF NEW YORK CITY.

BEFORE the 37th Congress of German Surgeons, in April, 1908, Bier (*Archiv. f. klin. Chir.*, Bd. lxxxvi, 1908, p. 1007) presented a method of local anæsthesia by the intravenous route which he had found extremely successful for the resection of joints, tendon transplantation, sequestrotomy, amputations of the various extremities, etc.

The method is applicable only to the extremities and briefly is as follows: The extremity to be operated upon is carefully bandaged with a soft rubber bandage from the distal end to a point sufficiently high to allow free access to the field of operation. This must be so done that all the blood is squeezed out of the extremity and kept out by a broad band above the field of operation. A second rubber bandage is wound about the extremity below the field of operation, enclosing it between the upper and lower bandages. Under infiltration anæsthesia a subcutaneous vein, close to the upper bandage, is exposed, if possible by a vertical incision,—if not, a transverse one will expose a vein without difficulty. The vein is freed, two ligatures passed beneath it, the upper ligature tied, and the vein cut across. An ordinary metal infusion cannula is then passed into the lower (distal) end of the vein and tied over it, firmly closing the vein about the cannula. Through this cannula the operator injects from 50 to 100 c.c. of 0.5 per cent. novocain solution in a direction opposite to the normal blood current. Anæsthesia results in from 5 to 10 minutes, due to the passage of the novocain solution through the vein wall, and is complete. The cannula is left *in situ;* injected solution must not escape.

When the operation is completed and before closing the wound, he washes out the veins with warm salt solution. As an additional precaution the upper rubber bandage is loosened sufficiently to allow the blood to flow through the arteries and thus to wash out still more of the novocain solution. After

the blood has flowed for a few minutes the bandage is again tightened, the wound sponged dry, and closed in the ordinary manner. The dressing is applied and the rubber bandages removed. In amputations the line of the incision passing through the injected area makes the washing out process unnecessary.

The anæsthesia lasts for from 5 to 15 minutes after washing out the veins. In nervous individuals Bier finds a preliminary dose of morphine and scopolamine very satisfactory.

A number of cases suitable for this procedure, in which general anæsthesia was contraindicated or not desired, led me to try it; in each case anæsthesia was complete.

The armamentarium is very simple. A 0.5 per cent. novocain-salt solution is carefully sterilized by boiling. The implements necessary are a silver infusion cannula of the ordinary type, a piece of rubber catheter to connect this with the tip of a glass syringe of the type with asbestos packing known to the trade as the McElroy syringe, large enough to hold 100 c.c.

In applying the rubber bandage to the extremity it causes less discomfort if the main arterial circulation is cut off by digital pressure, the limb elevated, and the bandage then applied from below upward and fastened and the lower turns unrolled. As in an intravenous infusion, the cannula can be more easily placed in the vein if the two ligatures are held taut and a small longitudinal slit made in the vein between them. Into this the cannula may be readily slipped. The upper ligature is tied and the lower one tied carefully about the cannula to prevent leakage, as recommended by Bier.

As the solution is forced in, the subcutaneous veins become prominent and the solution can be seen entering the entire area between the bandages. After a few minutes the veins become less and less prominent and finally are not distinguishable, due to the rapid diffusion of the fluid into the tissues. The remaining steps are those carried out by Bier. The following cases are chosen to illustrate the efficacy of the above method:

CASE I.—*Amputation of Leg for Tuberculosis.*—Male; aged 28 years. Bellevue Hospital, service of Dr. Woolsey; operation February 1, 1909. Morphine, ⅛ gr., one-half hour and another ⅛ gr. fifteen minutes before time set for operation. After the

usual preparation the femoral artery was compressed against the pubic ramus and the rubber bandages applied as above. The saphenous vein was exposed by infiltration anæsthesia, the ligatures passed, and the cannula inserted as described above; and 50 c.c. of 0.5 per cent. novocain solution were injected. In ten minutes anæsthesia was complete.

Anteroposterior flaps were made at the junction of the middle and upper thirds of the thigh and the skin flaps dissected back without the least pain to the patient. The muscles were divided down to the bone and pushed back sufficiently to allow for a high division of the bone. Throughout this step the only complaint by the patient was that he felt electric shocks in his leg, and when the sciatic was cut a shock twisted his big toe. The bone was sawed without any pain to the patient. The remaining steps, completed in the ordinary manner, were painless.

Throughout the patient's pulse ranged from 72 to 80, and on his return to the ward he enjoyed his midday meal. The day after the operation his temperature rose to 101° and then fell to normal on the fourth day, where it has remained. On the fourteenth day after the operation he was up in a chair for the first time in 14 months. The wound healed without unusual reaction.

CASE II.—*Hallux Valgus.*—Woman; aged 44; was admitted to Bellevue Hospital (Dr. Woolsey's service) on January 20, 1909, complaining of pain over both great-toe joints. Both great-toe joints were swollen and reddened, the bursæ filled with fluid, and the toes abducted so that they rested across the other toes.

After the usual preparation the rubber bandage was rolled over the toes and foot to a point just above the ankle on the left side, and fastened there. A vein was exposed and about 30 c.c. of 0.25 per cent. cocaine solution injected. The solution could be readily seen entering the veins over the dorsum of the foot and anæsthesia was complete in one minute. The bursa was dissected out, a wedge-shaped piece of bone removed from behind the head of the first metatarsal, and the toe manipulated into position with absolutely no sensation on the part of the patient. Before closing the skin incision the veins were thoroughly flushed with warm salt solution and the tourniquet loosened as recommended by Bier. The wound was then closed, dressed, and the tourniquet removed. At the end of one hour the patient complained of severe pain in the foot, which she described as tingling or burning in character, as "if it had been

frost-bitten." Three hours after the operation the patient had a shaking chill and said she felt sick and nauseated, but was relieved by ⅛ grain of morphine hypodermically. Her temperature rose to 102.5° F. and then gradually fell to normal. The wound healed kindly except at one point, where the skin became a little blue and looked doubtful and a stitch was removed, after which it granulated in rapidly.

Her sole complaint throughout was that the rubber bandage at the ankle was too tight, a just complaint, as I believe we had wrapped it with too much earnestness in our zeal to render the foot bloodless.

CASE III.—*Tuberculous Tenosynovitis of the Extensor Tendon Sheath of the Arm.*—Man; 35 years of age. The process involved the extensor tendon sheath from the level of the ulnar styloid about six inches up the arm, and was filled with small movable bodies.

After freeing the forearm of blood by compressing the bracheal and elevating the arm, the rubber bandage was applied from below upwards and fastened just above the elbow. A large vein on the ulnar side of the arm which had been previously selected was exposed under cocaine infiltration, the cannula inserted and 50 c.c. of 0.5 per cent. and 50 c.c. of 0.25 per cent. novocain-salt solution injected. Anæsthesia was complete in 15 minutes and the man, a rather stolid individual, watched the skin incision, saying that he had no pain although he saw me cutting. The tendon sheath was opened and dissected out, the wound wiped with the iodine-glycerine solution of Durante, and the tissues loosely closed over the tendons. The veins were flushed in the usual manner, a few bleeding points caught and tied, and the skin closed with two small rubber-tissue drains at each angle. He had no constitutional reaction.

From my experience novocain is the ideal anæsthetic for this method. Cocaine in the one case in which it was used gave a marked constitutional reaction, and although its action was more rapid the likelihood of dangerous symptoms is so much greater that it has nothing to commend its use.

Its superiority to infiltration anæsthesia for the types to which it (intravenous) is adapted is most marked. It is simpler, more rapid, and more complete, and will supplant the slower method in many cases.

A MODIFICATION OF THE CRILE TRANSFUSION CANNULA

BY BERTRAM M. BERNHEIM, M.D.,

OF BALTIMORE, MD.

From the Hunterian Laboratory of Experimental Medicine, The Johns Hopkins University.

THE instrument (Fig. 1) consists of a hollow tube 3 mm. long, having three rounded, sharp-pointed hooks on one end. These hooks are 2 mm. long, are placed at equidistant points around the lumen and flare outward just a bit at their tips. Between two of the hooks is the handle, which comes out in

FIG. 1.

The three-pronged cannula.

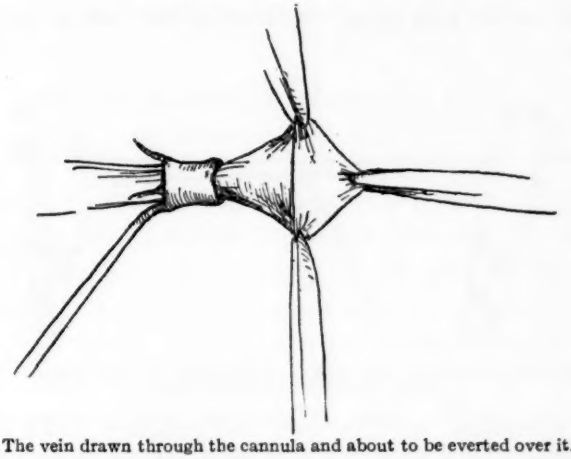
the same direction as the hooks, but, in addition to being much thicker, the handle is 2½ cm. long and is flattened a little so as to be easily held. The cannulæ are made in four sizes, referring to the bore, 1½ mm., 1¾ mm., 2 mm., and 2¼ mm.

The technic [1] of the transfusion is in most respects similar to that used for the Crile cannula. The vein of the donee is carefully isolated and, after being tied off distally and secured proximally by a bull-dog clamp, is divided, leaving about 3 cm. free for manipulation. The lumen of the vessel is thoroughly

[1] Crile: ANNALS OF SURGERY, September, 1907.

washed out with warm saline, followed by liquid vaseline, after which all superfluous adventitia is removed. The artery of the donor is prepared in a similar manner.

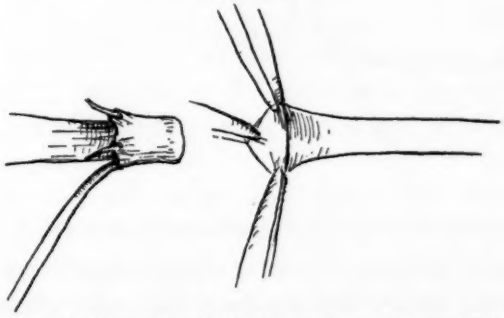
FIG. 2.



The vein drawn through the cannula and about to be everted over it.

The vein is then, by means of a needle and thread, passed through the cannula[2] (Fig. 2), hook end first, grasped by mosquito clamps at three equidistant points along its lumen, everted over the cannula and impaled on the three hooks

FIG. 3.



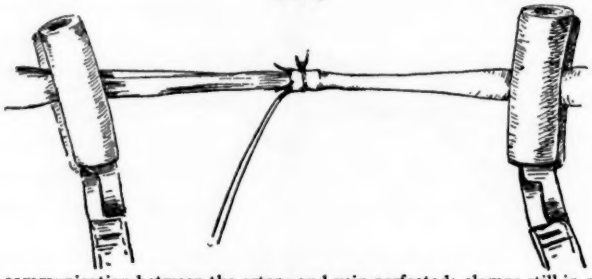
The vein passed through the cannula and everted over it, ready to receive the artery about to be drawn over it.

(Fig. 3). Next, the artery is seized in a similar manner by three mosquito clamps and, after being gently dilated, according to the suggestion of Crile, by the end of a clamp pre-

[2] The size of the cannula selected should be judged by the actual tissue thickness of the collapsed vein which is to be passed through it.

viously dipped in sterilized oil, is gently pulled over the cannula with its everted vein and also impaled on the three hooks. A tie is now placed around the cannula (Fig. 4), for the sake of greater security, and the blood allowed to flow, the clamp on the vein being removed before that on the artery (Fig. 5).

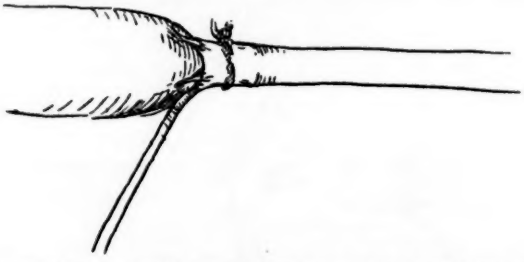
FIG. 4.



The communication between the artery and vein perfected; clamps still in place compressing the respective vessels.

The advantage of this over the ordinary Crile cannula is that it is absolutely unnecessary to hold either vessel while the tie is being placed around the cannula. This difficulty, slight as it may seem, is often a most serious drawback to

FIG. 5.



The artery and vein as finally secured together, and the flow of blood going on.

the successful performance of a transfusion.[3] As a matter of fact, if the artery has not been too much dilated before being impaled on the hooks of our cannula, no tie at all will be necessary, as there will be enough pull on the artery and vein to prevent leakage. As a routine, however, we think it best to put one tie around the cannula and vessels.

[3] Hepburn: ANNALS OF SURGERY, January, 1909.

THE "OPEN-SEAT" PELVIC BINDER.

A PRACTICAL BANDAGE FOR OPERATIONS ON THE SCROTUM AND TESTES AND ILIO-INGUINAL REGION.

BY SAMUEL E. NEWMAN, M.D.,

OF ST. LOUIS, MO.

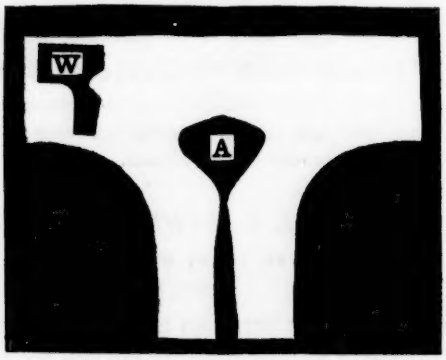
OPERATIONS about the scrotum and inguinal regions have been greatly improved and the results are not comparable with those of antecedent years. But it usually provokes strong comment to see the bandage applied after an almost technically perfect operation. To say the bandaging is crude, puts it lightly; and I therefore do not think my paper needs an excuse.

No part of the body seems more difficult to bandage properly than the scrotum, and probably none is so grateful for small attentions. The scrotum should neither hang like a bag nor be squeezed between the legs. Postoperative comfort is greatly augmented by supporting the part in a high posture. If this position, which is much desired and seldom obtained, can be secured there is less likelihood of venous oozing and serous effusion into the sack; the tension on the stitches is reduced to a minimum and primary union made more certain. Sometimes it seems as if the success of the surgical procedure is frustrated by the lack of proper support and protection of the part.

The convenience which the "open-seat" offers to both patient and nurse is of real importance, and no word of mine is necessary to point out the desirability of this special feature.

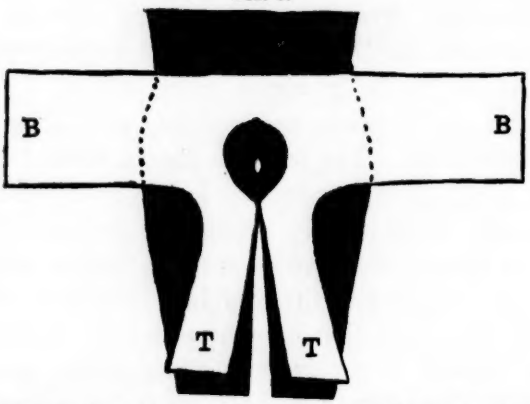
Material.—The full width of unbleached muslin is used; for the small size one and one-quarter yards, and for a large size one and three-quarter yards are sufficient. Two sizes will accommodate the usual run of cases. The material shrinks after washing and it is best to use a shrunken muslin for the bandage if it is to be laundered and re-applied. One

FIG. 1.



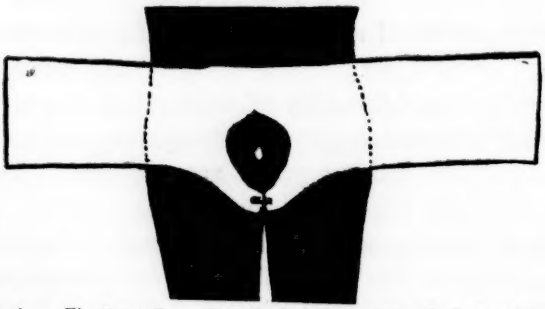
Cutting out the bandage. Fold the length of the material on itself, once. Cut the muslin as indicated at *W*. Open the doubled muslin and the resulting pattern should be Figure 1, a two-tailed binder cut out at *A* for the anal opening.

FIG. 2.



Applying the bandage, posterior view. The bandage is put in position so that the rectal opening is in the center of the bandage. The abdominal ends, *B*, *B*, are brought out to either side of the patient. The perineal tails, *T*, *T*, are under the thighs ready to be brought forward between the legs.

FIG. 3.

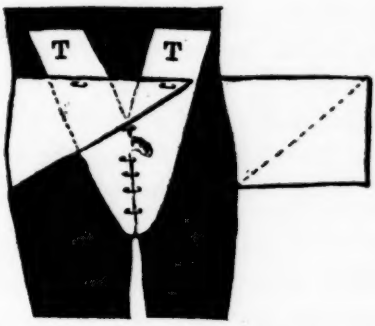


Posterior view. The two tails are brought forward between the legs and a safety-pin locks the two sides over the perineum.

FIG. 4.

Anterior view. From below upward the two tails are joined with a few safety-pins. A high opening is left for the penis. Very material assistance is gained if someone pulls on the tails while the pins are being inserted.

FIG. 5.



One side of the abdominal binder is folded into a triangle, brought across the abdomen and fastened. The other side is treated in the same way and any excess of material, *T*, *T*, is turned under.

FIG. 6.

The completed bandage. From below, where the bandage is open, push in a good quantity of cotton to bolster up the scrotum. This raises the part to a high position and protects the wound from contamination.

thickness of the material may be enough, but the binder is stronger and more lasting if it is composed of two layers and the edges nicely stitched together.

ADVANTAGES.

1. The patient is not lifted; turning on the side is all that is required in applying the bandage.

2. It is held in place by the spines of the iliac bones and does not tend to slip.

3. The scrotum is not merely supported between the thighs but rests on the pubes.

4. Urination is not interfered with.

5. Easy access to the rectum; defecation does not necessitate a change of the bandage.

6. The bandage does not become stringy and see-saw the skin of the entire region.

7. Inspection of the wound is easy and requires little more than the removal of a few safety-pins.

8. After dressing the wound the same bandage may be re-applied; if the binder is soiled, it is laundered and re-used.

NOTE ON SILVER FOIL IN SURGERY.

BY JOSEPH S. LEWIS, M.D.,

Intern at the German Hospital in the City of New York.

It is a repetition, but surely not a vain one, to assert the value of silver foil as a surgical dressing. Its use has become firmly established in some hospitals while disregarded or unknown in others.

Following the work of Müller (1899) and Naegli (1893), to which he refers, Bolton [1] in 1894 demonstrated the inhibitive and bactericidal action of various metals. Halsted,[2] founding the practical use of silver foil on the laboratory work of Bolton, introduced it into the wards of the Johns Hopkins Hospital in 1895.[3] Since then the use of silver foil dressing has been propagated largely by such as have seen it used in Baltimore.

In 1896 Credé [4] published his observations on the mode of action of silver and its compounds, his work resulting in a flood of literature which carried numerous silver compounds into general use. On the compounds we have nothing to add.

Metallic silver as an aseptic dressing derives its value chiefly from its bacterio-inhibitive power, sufficient to check bacterial growth but not to alter the normal process of repair in the adjacent healthy tissues. The foil is therefore in harmony with the practice of asepsis in this sense, that it does not destroy living somatic cells. As demonstrated by Credé, the dressing lies in contact with a clean open wound without change, but in the presence of growing bacteria the lactate is formed, wherein the inhibitive power has been found to reside. The bactericidal power of the lactate in stronger solutions is markedly less than Credé was at first led to believe [5]; and this is doubtless fortunate, for were it bactericidal in the proportion 1 to 80,000, as first stated, it must, barring selective action, surely kill body-cell with bacterium.

In practice silver foil has been found to do no harm, thus fulfilling the first desideratum of all therapeutic measures. This is the general experience,[6, 7] as well as our own at the German Hospital. Our conclusions are based on its routine use during the past four months on upwards of 200 unselected cases with especial observations of about 100 of these. That it is harmless does, of course, not alter the fact that it is of little or no value on certain wounds, as, for instance, chronic granulating surfaces. It cannot reach bacteria growing in such granulations, and the sheets are prone to incorporate with the dried pus of profusely discharging wounds and rise from contact with the surface.

Of what use then is the foil? The following advantages have been demonstrated in the order stated:

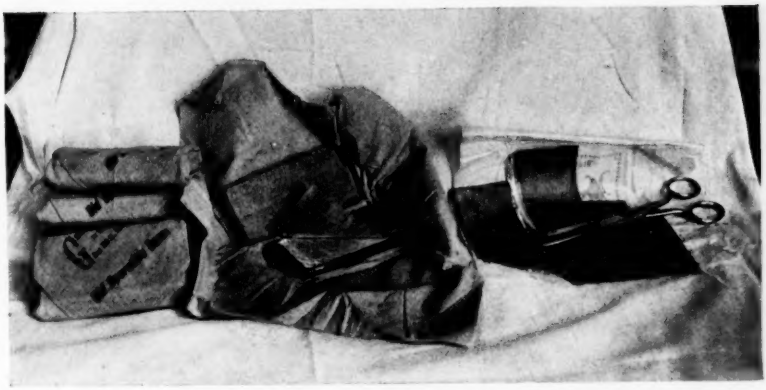
1. On clean skin grafts the dressing is at its best and has replaced the older methods of wet dressings and gutta-percha, or the dry gauze dressings which present mechanical drawbacks. The unguents are either too active if antiseptic, or favor bacterial growth, or amount to occlusive macerating dressings like gutta-percha. Under the foil the grafted skin remains fairly dry, as is the condition of normal skin. One clean graft under silver was observed to have taken firmly on the third day after operation. Others were not inspected until the expiration of a week or more.

2. In plastic surgery where cosmetic results are desirable, the slight secretion along the linear wounds passes through the crevices in the foil to be absorbed by the superimposed gauze, minimizing scab formation. This was demonstrated in control dressings in which one half of a wound was covered with gauze and the other with silver.

3. In the usual clean wounds the possibility of infection from without is made more remote, especially in the groin, where the dressing may become wet with urine or slip and so expose the wound. In clean wounds near a discharging one, as in some secondary operations, the clean one may be protected against the other until union is established.

4. Though we have used it in only one such case and that

FIG. 1.



The cut leaves are placed between boards to be sterilized.

FIG. 2.

Manner of manipulating the silver leaves.

too recently to add the ultimate results, the foil may be recommended on theoretical grounds to prevent subdural adhesions, for which we refer to an article by Harris [8] for practical demonstration.

5. In clean rapidly granulating open wounds, the foil protects the delicate advancing margin of epithelium. Chronic ulcers such as the varicose type are not benefited. In two cases it was found suitable in burns after the acute stage was passed, but of no preference over other methods. In the acute or painful stage of burns it is useless.

Silver foil is no longer at a disadvantage as regards its cost, in that it may now be had for one-fifth the price quoted as reasonable by Hagner [6] in 1901. One dollar a month more than pays for all the foil that is used in this hospital.

The following method of preparation and use is essentially that of Halsted, save that we deviate from the use of paper over the foil, as favoring retention beneath the dressing of the slight postoperative bleeding or exudation of serum. The gauze is placed directly on the foil through the breaks or cracks of which the fluids find their way. Where the gauze adheres to a graft it may be removed by the usual methods, though if bleeding has been absolutely stopped this does not occur.

The leaves are cut and placed between non-resinous boards of one-half inch or greater dimensions, and put into packages with squares of sheeting (Fig. 1). At the hospital, sterilization is accomplished in the autoclave. For the office a cover of wrapping paper or old sheeting protects the packages, to be baked in the oven for 15 minutes or until the paper is slightly scorched.

In handling the foil for dressings, too great nicety means loss of time and temper. The papers, not the silver leaves, are seized with damp fingers while the silver, which for the moment adheres to the paper, is placed on the wound (Fig. 2).

We are convinced that silver foil should be a familiar surgical dressing in every well-regulated hospital.

REFERENCES.

[1] Bolton: The Effects of Various Metals on the Growth of Certain Bacteria, Trans. Assoc. Am. Phys., 1894., vol. ix.

[2] Halsted: Reference to Introduction of Silver Foil, Johns Hopkins Hospital Reports, vol. vii, p. 224.

[3] Bloodgood: Ibid., p. 371.

[4] Credé: Silber als Antisepticum in chirurgischer und bacteriologischer Beziehung, Arch. f. klin. Chir., vol. liii, 1906.

[5] Zajontschkowski: Bacteriologische Untersuchungen über die Silbergaze nach B. Credé, Centralblatt f. Chirurgie, vol. xxiv, 1907.

[6] Hagner: Metallic Silver as Suture and Dressing, Nat. Med. Rev., April, 1899.

[7] Gauthier: Sur l'emploi de fils d'argent cables pour les sutures et des feuille d'argent laminés pour les pansement, Assoc. Franc. de Chir., 15 Cong. de Chir., 1902.

[8] Harris: The Use of Silver Foil to Prevent Adhesions in Brain Surgery, Jour. Am. Med. Assoc., vol. xlii, 1904.

TRANSACTIONS
OF THE
NEW YORK SURGICAL SOCIETY.

Stated Meeting, May 12, 1909.

The President, Dr. Joseph A. Blake, in the Chair.

ENUCLEATION OF THE TONSILS.

Dr. Frank S. Mathews presented a number of children whose tonsils he had removed by the finger-enucleation method. In one of the cases the operation was done a year ago; in another, only a week ago.

The cases were shown in order to illustrate the fact that by this method surgeons are less likely to injure the wall of the pharynx than by the methods in which knives, scissors and dissectors are used and the normal architecture of the pharynx may be interfered with. After complete enucleation of the tonsil the wound healed as well and even better than after tonsillotomy, and cicatrization, the result of injuring the pillars and which was apt to draw the uvula to one side, was absent.

In addition to the patients, Dr. Mathews showed a number of tonsils that had been removed by this method.

URETERAL CALCULUS IN A CHILD: TRANSPERITONEAL AND RETROPERITONEAL REMOVAL.

Dr. John F. Erdman presented a child, 7 years old, who had been the subject of impacted calculus in the right ureter, directly over the spine of the ischium. The patient's symptoms dated back for three years, consisting chiefly of hæmaturia and pain simulating appendicitis. The child was X-rayed three different times, each picture showing a ring of shadow in the course of the right ureter over the spine of the ischium. The ureter was reached without much difficulty through a transperitoneal retroperitoneal incision, and the calculus was removed. The child's convalescence was uneventful, the wound healing in the course of two weeks.

NEPHRECTOMY FOR TUBERCULOSIS OF THE KIDNEY.

Dr. Benjamin T. Tilton presented a kidney, together with the person from whom it had been removed. The patient was a girl of 18 years, who up to a year and a half ago had been well with the exception of an attack of smallpox at the age of 6. There was no family history of tuberculosis or renal disease. Eighteen months ago she began to have pain in the right loin, accompanied by frequent and painful micturition. She never noted anything abnormal in the character of the urine. Three months later she was operated on at another hospital, an incision being made in the right loin, and pus evacuated. She remained in the hospital for three months and left with a discharging sinus. From that time up to February 2 last (about 16 months) she complained of nothing excepting the discharging sinus, for the relief of which she came to the hospital.

Examination at this time showed an anæmic but fairly well nourished young woman. Heart and lungs were negative. In the region of the right kidney a good-sized mass was easily made out by palpation, and was somewhat tender. Posteriorly, a sinus discharged a moderate amount of pus. The edges of the sinus were pale and flabby. The patient's temperature ranged from normal up to 100.8. The urine was clear; specific gravity, 1010; urea, 1.6 per cent. It contained no albumin, and microscopically a few epithelial cells.

Cystoscopic examination showed a healthy bladder, with no signs of cystitis. The right ureteral orifice was contracted, and no urine flowed from it. The left ureteral orifice was normal in appearance, and clear urine issued from it.

A diagnosis was made of tuberculosis of the right kidney, with occlusion of the right ureter, and a healthy left kidney. Nephrectomy was decided upon. Thinking that the first operation had been a nephrotomy, Dr. Tilton said he anticipated a great deal of difficulty in removing the kidney in the presence of dense adhesions to the surrounding structures. To his great surprise, upon cutting down upon the kidney, he found that it shelled out with the greatest ease, there being only the thinnest adhesions with the surroundings. This was accounted for by the fact that the kidney had not been opened at the first operation, but merely a perinephritic abscess incised and drained. The primary source of the abscess, namely, the tubercular kidney,

had been left intact, and therefore had not become the seat of secondary pyogenic infection with resulting adhesions to the surrounding parts.

The ureter was exposed for several inches, and tied separately from the vessels. Chromic gut was used for both ligatures. The patient reacted well from the operation, and made an excellent recovery. She had gained about ten pounds in weight since the operation, which was done a little over two months ago. The sinus had not entirely healed, but the discharge was very slight.

The specimen showed a caseous degeneration of the entire kidney, with liquefaction in some portions. There was found a minute communication between the interior of the organ and the sinus, which accounted for the persistent discharge from the fistula in the loin.

Dr. Tilton said the case demonstrated the possible origin of a perinephritic abscess from a tubercular kidney, and the incompleteness of the result of simple incision of such an abscess. Whether or not it was desirable in every case of perinephritic abscess to examine the kidney at the time of operation was probably a matter of individual judgment. If, however, there was a distinct history of renal symptoms, it would seem a wise course. In this particular instance such an examination would have led to the discovery of tubercular disease of that organ, and a nephrectomy would have saved the patient the discomfort of a sinus persisting for a year and a half.

Dr. Howard Lilienthal, discussing Dr. Tilton's suggestion that in some cases of perinephritic abscess an examination of the kidney itself might reveal its tuberculous character and lead to an immediate nephrectomy, said that in many instances where the abscess was large and the kidney in bad condition such a procedure would cause tremendous shock. On the other hand, by drainage and delay, we were apt to get troublesome adhesions, and to obviate these difficulties the speaker said that in a number of cases he had resorted to a nephrectomy in two stages. He first opened the abscess and drained the kidney, if necessary, and then, five or six days later, removed the kidney. By that time the size of the organ would have diminished, the abscess cavity would be largely obliterated, and the completion of the operation would be comparatively safe and easy.

APPENDICITIS: A SERIES OF 105 CONSECUTIVE OPERATIONS WITHOUT MORTALITY.

DR. CHARLES N. DOWD read a paper on this subject, and showed a number of patients illustrating the same. (See page 762.)

DR. LILIENTHAL said it was not often that we heard of 105 unselected consecutive cases of appendicitis without a death. Both Dr. Dowd and the patients were to be congratulated upon such an excellent showing. The speaker said he was heartily in favor of the method described by Dr. Dowd, and had practiced it himself. Its main feature was not to interfere any more with the peritoneum than was absolutely necessary, neglecting the presence of intraperitoneal fluid, even pus.

POPLITEAL ANEURISM: RECONSTRUCTIVE OPERATION.

DR. JOHN A. HARTWELL presented a man, 42 years old, who was admitted to Bellevue Hospital on February 11, 1909. His family history was unimportant, and he gave an indefinite history of syphilis. His occupation, which was that of a machinist, entailed hard work, but there was no history of his ever having injured his knee.

About six months ago he noticed a small swelling in the left popliteal space, which had gradually increased in size. It was the seat of a constant dull, aching pain. At times he had noticed that his leg was of a bluish color, but there had been no symptoms referable to nerve pressure.

Physical examination in general was normal, and there were no positive evidences of syphilis. In the left popliteal space there was a typical aneurismal swelling the size of an orange, which gave all the classical signs of that condition. It was apparently of the sacculated type. Pulsation was absent in the dorsalis pedis and posttibial arteries.

Operation, February 19, 1909, under gas and ether anæsthesia. A Martin bandage was applied from the foot to the upper third of the thigh, completely emptying the sac. An 8-inch incision was then made over the tumor and carried downward through the tissue to a false aneurism sac, with the vein and artery lying on its external, posterior aspect. The sac was then opened, freed of blood clots, and was found to communicate with

the arterial lumen by two openings lying on the anterior internal aspect of the artery. There were no blood clots in the inside of the artery, and the arterial wall, although somewhat dilated and thickened, seemed comparatively normal excepting at the sites of the rupture. The intima seemed normal. The two openings, one about an inch and a half, the other about half an inch in extent, were closed with fine silk, thoroughly vaselined, threaded on No. 16 needles. Two rows of sutures were applied in such a way as to closely approximate the intimas. The constricting bandage was then removed and the blood freely pulsated through the artery. It was then noted that the condition was a fusiform aneurism, and with the full force of the circulation the artery dilated in its centre to about one inch in diameter, the longitudinal extent of the dilatation gradually decreasing in either direction for about two inches. It was feared that a recurrence would take place if left in this way, so a further operation was undertaken. The artery was digitally compressed above the seat of the disease, the fusiform sac was split throughout its length, and a reconstructive operation was done, leaving a canal of normal size, the intimal surfaces being brought in contact by means of chromic gut sutures on a curved needle. The remainder of the sac was sutured down over this with chromic gut, three layers in all being used. On releasing the compression, blood circulated freely through the newly formed canal. The wound was sutured with a small drain in the false sac.

Circulation in the leg and foot was sufficiently good on the day following the operation, although no pulsation ever returned in the distal arteries. Four days after the operation there was evidence of a blood collection in the false sac, with a rise in temperature. The superficial wound was opened, and a collection of blood and serum evacuated which was just beginning to undergo suppuration. This was washed out and a drain inserted. An examination of the reconstructed artery showed pulsation as far down as the middle of the operative site; below this it was obstructed, with the evident formation of a clot. At the second dressing, two days later, this clot occluded the entire site of the arterial operation.

On March 20, the first time the patient was allowed out of bed, there was a sharp hemorrhage, which was controlled by a tourniquet, applied for half an hour, with subsequent firm pres-

sure over the popliteal space. The source of the bleeding was not determined. The subsequent history of the case was uneventful. The wound in the false sac granulated, leaving a moderate amount of contraction at the knee joint, which was gradually growing less.

The case was shown because of the interest attached to the failure of the reconstruction of the artery, although the result, so far as the circulation in the leg was concerned, was entirely satisfactory. It was not believed that the infection within the false sac was in any way the cause of the failure, because the artery itself was not in contact with the infection, and that part of the operative field showed no evidence of suppuration at any time. If an infection in the arterial wall was present, it was not sufficiently marked to show gross signs. Had the necessity for reopening the wound not arisen, so that direct inspection of the artery was possible, the case would undoubtedly have been accepted as one of success of the reconstructive operation,—for the functional result was good, and any subsequent absence of pulsation in the popliteal artery would have been explained by the formation of cicatricial tissue over and around it.

SECONDARY GASTRO-ENTEROSTOMY.

Dr. Hartwell presented a man of 34 who was admitted to Bellevue Hospital on April 9, 1909. His family history was unimportant. He was operated on at Bellevue Hospital in 1903 by Dr. George Woolsey for an acute exacerbation of recurrent appendicitis, and the appendix was removed. His recovery from that operation was uneventful. He was readmitted to the hospital, in Dr. Woolsey's service, on January 14, 1908, and gave the following history: For the preceding eight or nine months he had suffered from symptoms pointing to gastric ulcer, and he had been treated in the City Hospital for that condition. His chief symptoms were gastric pain and the vomiting of blood. On January 11 he was seized with persistent vomiting, and there was more or less abdominal pain, which was most severe in the region of the epigastrium.

Examination on admission gave the findings of a subacute perforation of a gastric ulcer, for which an immediate operation was done by Dr. Woolsey. Examination of the stomach showed some adhesions about the posterior wall in the lesser sac, which

was the apparent site of the ulceration. The pylorus was found to be patent, and the stomach was not materially dilated. No acute perforation was present, and, in the absence of pyloric stenosis, a gastro-enterostomy was deemed inadvisable. The adhesions on the posterior wall were not disturbed. The post-operative course was uneventful, and the patient was discharged on February 4, apparently in good health, and without gastric symptoms. He remained well until March, 1909, when there was a recurrence of the previous symptoms. For three weeks prior to his recent admission to Bellevue Hospital on April 9, he had been suffering almost continuously from colicky, cramp-like pains in the epigastrium, radiating under the costal margin to the right lumbar region, and occasionally to the left shoulder. He had vomited practically everything ingested during this time, but there had been no blood in the vomitus.

The patient had the facies of abdominal suffering and was moderately emaciated. Examination showed no abnormality excepting that due to the abdomen. Here, scars of the previous operation were seen, and palpation over the epigastric region, particularly just beneath the ensiform, caused marked pain. The stomach was apparently enlarged. No masses could be made out and there was an absence of abnormal rigidity.

Gastric analysis, one hour after a test meal, showed 250 c.c. of undigested food. Total acidity, 50 c.c.; free hydrochloric acid, 10 c.c.; loosely combined acid, 22 c.c. No lactic acid. During the week that he remained under observation in the ward he suffered constant pain, but on a very limited diet; there was no vomiting.

Operation: This showed the stomach to be dilated to at least twice its normal size, though the pylorus seemed to be patent. There was a marked absence of adhesions. On the anterior surface of the stomach, near the lesser curvature, and about an inch and a half from the pylorus, there was an indurated area, apparently the seat of an ulcer. On opening the lesser sac through the transverse mesocolon there was an absence of the adhesions described at the previous operation, and no evidence of ulceration existed. Posterior gastrojejunostomy was done by the no-loop method without reversal, sutures and clamps being used.

Since the operation, the patient has been entirely free from

pain, and there has been no vomiting excepting on the second day, when he vomited a small quantity of powdered milk curd, the first food ingested.

PRIMARY TUBERCULOSIS OF THE BREAST.

DR. HARTWELL presented a woman, 21 years old, who was admitted to Bellevue Hospital on February 19, 1909. Her family history was good, as was also her past history. There were no evidences of tubercular or venereal infection. She had never been pregnant.

About nine weeks prior to her admission to the hospital, the patient, on stooping, struck the lower outer quadrant of her left breast rather sharply against the corner of a table. Four weeks later, the breast, at the site of the injury, began to swell and show evidence of an inflammatory reaction, with the subsequent development of an abscess. One week ago this was incised, a small quantity of pus was evacuated and the cavity was drained.

Physical examination at the time of admission showed the patient to be a well-nourished young woman, above the average height, and of rather slight build. Aside from the condition of the left breast, examination showed nothing abnormal excepting scars on the inner aspect of the left arm and low in the axilla, the result of an old burn. The left breast was the seat of an inflammatory lesion involving the lower outer quadrant. There was a swelling, irregular in outline, lobulated, giving somewhat the feel of an adherent mass of glands, the skin over which was reddened and ulcerated in the centre, with a discharging sinus. The general appearance of the skin and sinus, with the granulation tissue underlying it, was that of tuberculosis. The involved portion of the breast was firm to palpation, and gradually shaded off into the normal breast tissue surrounding it. The diseased portion was somewhat tender to manipulation, and the axillary lymph-nodes were distinctly enlarged and tender.

The patient's temperature, on admission, was normal; pulse, 70. The leucocyte count was 16,000 with 74 per cent. polymorphonuclears. An incision made in the centre of the lesion prior to the resection evacuated a considerable quantity of tuberculous-looking pus. A small section of the tissue about the sinus was removed and submitted to Dr. Charles Norris, who pronounced it a tuberculous inflammation. The Von Pirquette and Calmette reactions were both negative.

Operation, March 26, 1909: This included a complete resection of the breast and axillary contents, the pectoral fascia being removed because it seemed to be involved in the process, but the muscles themselves were not disturbed.

The wound healed throughout the greater part of its extent primarily, although a small sinus persisted near the centre, which healed by granulation. About three weeks later a small collection of pus again formed at this site, and here a sinus still persisted. Material taken from this sinus on May 10 by curettage showed microscopically granulation tissue, without giant cells, and without definite evidence of tuberculosis. A second Von Pirquette done on May 10 gave a negative result.

The complete pathological report on the specimen removed was as follows:

The specimen consists of a breast and axillary contents. Just above the nipple is a circumscribed ulcer about 15 mm. in diameter, circular in outline, with sloughing base, which extends almost completely through the skin. Just to the outer side of the nipple is another ulcerated area about 15 mm. x 30 mm., of similar character, extending completely through the skin. On section of the breast tissue, there is a diffuse, pale, firm mass, invading the fat tissue, this lying immediately beneath the nipple and below it. Tissue of similar character is present immediately subjacent to the ulcers described. The lymph-nodes in the axilla are slightly enlarged and pale.

Microscopic Sections of the breast show slight hyperplasia of the glandular structure. The firm, white tissue described grossly is seen to consist of œdematous connective tissue between the fibrils, of which there is a considerable accumulation of lymphocytes in larger and smaller masses, and in places one sees definite circumscribed collections of epitheloid cells, the outer zone of which is bounded by lymphocytes; many of these contain large giant cells with their nuclei peripherally and radially situated. These tubercles are seen not only in the dense mass described, but in lymph spaces at some distance from the larger mass. Subjacent to the superficial ulcers are seen small clefts in the tissue lined by cells of similar character and distribution to those above just described.

Diagnosis: Tuberculosis of mammary gland.

The axillary lymph-nodes show evidence of chronic hyperplasia, without evidence of granuloma or tumor. No tubercle bacilli could be demonstrated in section of the breast stained for them. The spirochæta pallidum was also absent.

The case was presented because of the comparative rarity of tuberculosis of the breast as an apparent primary lesion. A most careful physical examination in this case fails to disclose any evidence of any other focus of the disease.

Dr. Alexander B. Johnson said he wished to put on record a case of primary tuberculosis of the breast which came under his observation some years ago. The patient was a middle-aged woman with a tumor of the left breast which she said had existed for several years, but which had recently begun to increase rapidly in size. The appearance of the growth was that of a large carcinoma, involving almost the entire breast. The skin overlying it was reddened, and it suggested an extremely rapid type of malignant disease. The glands in the axilla were moderately enlarged. Upon removing the breast, together with the muscles and the axillary contents, it was found that the tumor was an ordinary fibro-adenoma; but the entire gland, including the nipple, was the seat of an acute miliary tuberculosis. The enlargement of the axillary lymph-nodes was due to a simple inflammation. The woman made a perfectly good recovery.

OPERATIVE TREATMENT OF FRACTURE OF THE NECK OF THE FEMUR.

Dr. Royal Whitman presented six cases illustrating operative methods in the treatment of fracture of the neck of the femur for the purpose of restoring the function of the injured part. The first patient was a girl 16 years of age, who two and a half years ago was brought to the Hospital for Ruptured and Crippled for the treatment of what was supposed to be hip disease. A diagnosis of epiphyseal fracture of the neck of the femur was made and the joint was opened by the anterior incision, exposing the extremity of the neck which, as in all cases of this type, was displaced upward and forward, lying in front of the head of the femur. A thin section was removed sufficient to permit the insertion of a chisel between it and its head, and by prying and rotation of the limb the displaced parts were brought into perfect apposition. The patient, who at the time of the operation was completely disabled, is now presented as a perfect functional cure.

The second patient shown was a girl 15 years of age who had been admitted to the hospital in December, 1907, for hip disease. The limb was flexed, rotated outward, and there was pain and muscular spasm on attempted motion. There was no history of injury. The joint was opened and the displacement was identical

with that of the last case, as was the treatment. The result also was perfect functional recovery.

The third patient was a young man 19 years of age, who fourteen months before he had come under observation had fallen on the ice, the injury causing apparently an incomplete epiphyseal separation. He continued to limp about for a year or more when another fall completed the fracture and caused practical disability. The same operation was performed as in the other cases, but the replacement of the fragments was somewhat more difficult owing to the delay. The result is very satisfactory. There is but slight limp, a fair and increasing range of motion. The patient suffers no discomfort and is at work as the driver of a truck.

The fourth patient, a boy 16 years of age, differed from the others in that he was of the large, fat, overgrown type in which there was evident predisposition to deformity. The fracture had been induced by a slight injury. The operation was performed about six months after the injury; the method and the result differed in no essential from those of the preceding case.

The fifth patient, an amateur acrobat 18 years of age, about two years ago had fallen a distance of thirty feet. He was taken to a hospital where he received the accepted treatment for an impacted fracture of the neck of the femur. Two months later he was discharged with the advice that the limb be used; but as there had been no improvement he came to the Hospital for Ruptured and Crippled, where he was admitted for the treatment of ununited fracture of the neck of the femur. Upon opening the joint it was found that the neck of the femur had been in great part absorbed by the friction induced by motion and pressure. Its extremity was freshened, brought into apposition with the head and fixed by a drill passed through the trochanter. Firm union resulted. There is now free and painless motion but slight limp, and function is steadily improving.

This case illustrates the fact that inefficient treatment, even in a most favorable case, may be followed by the same unfavorable result as when applied to the adult type of injury.

The last patient was a boy 12 years of age, who two years ago fell from a car, fracturing the neck of the femur. He received no treatment and union followed with deformity of the coxa vara type. He was admitted to the hospital last year because of

limp, pain and distortion of the limb—symptoms directly dependent upon the depression of the femoral neck. The indication was therefore to restore the normal angle, and this was accomplished by the removal of a wedge of bone from the base of the trochanter, sufficient to permit full abduction of the thigh. The result is perfect functional recovery.

ENDOTHELIOMA OF THE CAROTID BODY.

Dr. Howard Lilienthal presented a woman, 56 years old, who gave a history of having had a small lump on the left side of the neck for the past thirty years. For the past five years this had become considerably larger, especially during the past year, when she became alarmed and wished to have it removed. The diagnosis of tumor of the carotid body was made before the operation, which was done about a month ago.

Upon exposing the growth, it was found that it involved the vessels to such a degree that it became necessary, as a preliminary step, to ligate and sever the internal jugular and common carotid quite close to the clavicle. The incision extended from below the ear, forward to the midsternal region, and then backward along the clavicle. The dissection was an extremely difficult one, lasting over an hour. The left pneumogastric nerve rested on the posterior surface of the tumor and was peeled off, as the speaker said he did not want to run the risk of causing the sudden death of the patient by resecting it.

On the day after the operation the patient was completely aphasic and had a well-marked hemiplegia. The left eyeball was soft, with contraction of the pupil. The aphasia and the paralysis of the hand due to the cerebral anæmia rapidly disappeared, but the pupil of the left eye was still smaller than that of the right. The ocular symptoms were due to injury of the superior cervical sympathetic ganglion.

In discussing the prognosis of this case, Dr. Lilienthal said he had not the slightest doubt that there would be a local relapse. He recalled a similar case which was inoperable, where the patient finally became cachectic and died of general weakness, but without metastases.

Dr. John F. Erdmann said that about ten years ago he operated on a case in which he excised about half an inch of the left pneumogastric nerve without any resulting bad effect.

VOLKMANN'S ISCHÆMIC PARALYSIS.

DR. HOWARD LILIENTHAL presented a boy of 12 years who in September, 1908, fell while walking in the street, breaking both bones of the right forearm. The double fracture was treated by an anterior and posterior splint. Subsequently, he developed a marked case of Volkmann's ischæmic paralysis, for which he was operated on by Dr. Lilienthal on January 18, 1909, four months after the accident.

An incision was made over the radius and ulna, removing about an inch of bone from each, and then introducing intramedullary aluminum splints, as devised by Dr. Charles A. Elsberg, and the hand was put up in the position of extreme extension. Primary union with good position of the hand followed the operation, but gradually the arm again became somewhat contractured. The elbow was now perfectly straight, and the boy had good use of the hand, thanks to the untiring efforts of the patient's mother who practised daily massage and passive motion.

DR. WHITMAN said he would advise in all cases of this character, before resorting to resection of the bone, the gradual correction of the deformity by splints, after the method of Jones. It was a treatment, however, that required a persistent attention for many months, without which it would always fail.

DR. ALFRED S. TAYLOR said that a little over a year ago he presented a case in which he had done the same operation as that described by Dr. Lilienthal, and, as in this case, there was a recurrence of the deformity. That recurrence took place in spite of vigorous and faithful massage by a professional masseur. The trouble in his case, Dr. Taylor thought, was due to the fact that the muscles were cicatrized, and the bones, after having been resected, continued to grow. He saw no good reason for shortening the bones nor lengthening the tendons, because both of these steps were unnecessary if there was sufficient muscle tissue. According to the literature, the method advocated by Jones had given many good results. There was another method which he had resorted to in cases of strong contracture of the muscles, and in one instance where there was marked posterior deformity of the wrist. Within four months, by the method described by a French writer named Martin, the hand could be brought into a position of extreme flexion. The method consisted, essentially, of building a steel framework over the forearm, and applying

elastic traction to the contractured muscles. This method was much more effective than any plan of rigid extension, such as was advocated by Jones.

Another important factor in the treatment of Volkmann's ischæmic paralysis, Dr. Taylor said, was to pay particular attention to the condition of the nerves. They should be released at the earliest possible moment from cicatricial pressure, so as to hasten regeneration.

DR. LILIENTHAL, in closing, said that while in certain cases he might be induced to try massage and passive extension without operation, he was convinced that any apparatus that was put on an arm of this kind had to be watched with the greatest care,—otherwise, ulceration was apt to result, as in these patients there seemed to be an inherent tendency to traumatism of the soft parts. As to the danger of non-union after resection of the bones, that possibility could be avoided by the use of the intramedullary splints.

MULTIPLE LIVER ABSCESSES.

DR. LILIENTHAL presented a man, 43 years old, who was admitted to the hospital on March 23, 1909, with the history of having had three attacks of gall-stone colic, the last one being accompanied by slight jaundice and fever.

Examination showed marked tenderness and rigidity in the right hypochondrium. The blood count showed 15,200 white cells, with 95 per cent. polymorphonuclears. On March 26 the abdomen was opened through the right rectus muscle, exposing the gall-bladder. The entire surface of the liver, particularly the left lobe, was studded with small abscesses, and by palpation one could make out crater-like depressions in various parts of the liver. A number of these abscesses were incised, evacuating considerable pus. The gall-bladder was then opened and drained, after removing a number of calculi. The patient made an uneventful recovery, with the exception of a gall-bladder sinus which still persisted. A culture from one of the abscesses showed a bacillus coli infection.

This case was shown, Dr. Lilienthal said, on account of the extreme rarity of this condition. It was the second case he knew of where recovery took place after multiple miliary abscesses of the liver had been actually demonstrated at operation.

INTESTINAL RESECTION FOR STRANGULATED HERNIA.

DR. LILIENTHAL presented a man of 30, who on March 28, 1909, developed acute intra-abdominal symptoms which his physician recognized as being due to a strangulated left inguinal hernia, and advised him to go to the hospital at once. The man refused to go until the next day, and when Dr. Lilienthal saw him that morning the patient was in a condition of extreme shock as the result of a very aggravated form of strangulation, with œdema and ecchymosis involving the abdomen, scrotum and penis.

An immediate operation was done, disclosing a mass of blackened intestine which had entirely lost its lustre, and which involved at least four feet of what was apparently the ileum. The mesentery was thrombosed, with an entire absence of pulsation. It was incised in several places without resulting blood flow. A rapid resection of the gut was made by the method which Dr. Lilienthal had described at a meeting of the society several months ago. The segment that was to be resected was first tied off, then cut, the cut ends carbolized, and a side-to-side anastomosis made. The patient made an excellent recovery. The ends of the sutures used in tying off the gut were left hanging out of the wound, and came away on the fourteenth day. There was never any leakage of intestinal contents. By actual measurement, four feet of gangrenous intestine was resected.

Dr. Lilienthal said he showed this case with the object of again emphasizing the ease and rapidity with which this method of intestinal resection could be completed. In this case the patient's condition was such that any prolonged method would probably have proven fatal. In reply to a question, the speaker said he regarded the side-to-side anastomosis much quicker than the end-to-end, and in cases demanding great haste it was infinitely safer.

INJURIES OF THE KIDNEY.

DR. ALEXANDER B. JOHNSON read a paper with the above title, for which see page 715.

DR. LILIENTHAL said that one thing that struck him in listening to Dr. Johnson's paper was the enormous disparity between the number of cases of injury to the kidney in the male as compared to the female, and this difference was hardly explained satisfactorily by the reason given by the reader of the paper. It

was perhaps due to the fact that cases of movable kidney were much more frequently met with in the female than in the male, in children as well as in adults, and a freely movable organ was much more likely to escape injury than one that was firmly fixed.

Dr. Ellsworth Eliot, Jr., briefly reported a case of posterior shot wound where the bullet, after perforating the gall-bladder, grazed the hepatic flexure of the colon and then passed through the right kidney and a part of the pedicle. The injury produced an extensive extravasation of blood. The gall-bladder and the injured kidney were removed, and the subsequent convalescence of the patient was interrupted by a perinephritic suppuration which was relieved by a counter-opening through the loin.

Dr. Benjamin T. Tilton reported a case of kidney injury, giving rise to symptoms similar to those of an acute peritonitis. The patient was a boy of 10 years who was run over. He was severely shocked, and about the seventh day showed signs of peritonitis, viz., abdominal rigidity and tenderness, a high temperature, and vomiting. A median incision was made, which disclosed some free serous exudate in the peritoneal cavity. A second incision was then made over the kidney, opening a urinary abscess originating from a ruptured kidney. The abscess was drained, the peritoneal symptoms subsided, and the boy made a good recovery.

CORRESPONDENCE.

"TOTAL EXCISION OF THE SCAPULA FOR SARCOMA."

EDITOR ANNALS OF SURGERY:

In the ANNALS OF SURGERY for July, 1909, Dr. de Nancrède publishes an exceedingly interesting article giving the end results after total excision of the scapula for sarcoma. He has succeeded in collecting 65 cases in which the scapula alone was excised, and 9 in which more than the scapula was removed, 25 of these cases being tabulated by him for the first time.

Dr. de Nancrède's conclusions are certainly very pessimistic, but no more so than the statistics would seem to warrant, while between the lines one can probably read a doubt as to the correctness of the diagnosis in the few cases in which death did not ultimately follow from recurrence. It is probable that quite a number of other cases could be reported, but it is hardly likely that any of the successful ones have failed to be recorded.

While it is doubtless true that the prognosis in these cases is almost absolutely hopeless as to end results, nevertheless the operation itself presents no technical difficulties. Its immediate mortality should be almost *nil*, and the patient will have at least a few months of comfort and of hope, while there is always a bare possibility of even a permanent cure.

The two cases which I report only strengthen the contention of Dr. de Nancrède.

CASE I.—Mr. F. K., aged 56; farmer; Grove City, O. November 26, 1901. Physician, Dr. William Hoover. First noticed pain and stiffness in right shoulder about a year before. This had at first been regarded as rheumatic, but a growth manifested itself in three or four months. Had lost 15 pounds in weight. Pain quite severe. On personal examination the tumor was found to be nearly the size of the fist, and to have involved in its growth the joint and probably the upper end of the humerus. The axillary glands were also involved.

At the operation the entire clavicle and scapula were removed, together with the arm, and thorough cleaning out of the axilla. The growth was pronounced an osteosarcoma. Patient went through the operation nicely, and went home in fine shape. There was no recurrence at the point of operation, but the right lung became involved, and he died March 23, 1902.

CASE II.—Mrs. J. M. K., aged 39; West Leipsic, O. Physician, Dr. C. E. Beardsley, Ottawa, O. September 8, 1904. The patient was mother of four children. Eighteen months before had fallen in such a way as to strike the point of the right shoulder. No bruise was noticed at the time, but some soreness had persisted and had been attributed to rheumatism. A lump had been noticed two weeks before. Pain was of a dull character. Motion of the arm somewhat limited. Patient was an exceedingly well-nourished woman, the picture of health. The tumor involved the right scapula, was smooth in outline, and somewhat elastic. Did not extend above the spine. Skin not involved. The tumor seemed to be about two inches thick. (A brother of the patient had died of osteosarcoma.)

At the operation the entire scapula was removed, the operation being attended with no special difficulties. The disease seemed to be limited to the body of the bone, though both anterior and posterior surfaces were involved. The spine and other bony processes seemed to be free from disease. No involvement whatever of the clavicle, humerus, or the joint.

Patient made a rapid convalescence and returned home in fine condition, and with very satisfactory use of the arm. She remained free from any evidence of return until the following February; then there was a gradual development of a general sarcomatosis, and she died October 5, 1905.

The extent of the tissue involved in the first case led necessarily to a very unfavorable prognosis, and the recurrence was so prompt as to render it perhaps questionable as to whether anything was gained by the operation. At the time of the operation, however, every motion of the arm was attended with great distress, and this was entirely relieved by the surgical intervention. In the second case there was a clear gain of several months of good health, and I think life was unquestionably prolonged by the operation.

JAMES F. BALDWIN, M.D.

COLUMBUS, OHIO.

TO CONTRIBUTORS AND SUBSCRIBERS:

All contributions for Publication, Books for Review, and Exchanges should be sent to the Editorial Office, 386 Grand Ave., Brooklyn, N. Y.

Remittance for Subscriptions and Advertising and all business communications should be addressed to the

ANNALS OF SURGERY,
227–231 South Sixth Street,
Philadelphia.